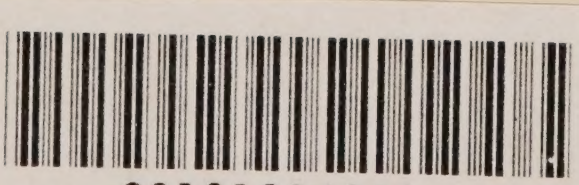
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THE CHILD

His Origin, Development and Care

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BY

FLORENCE BROWN SHERBON, A.M., M.D.

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Department of Home Economics
University of Kansas

First Edition

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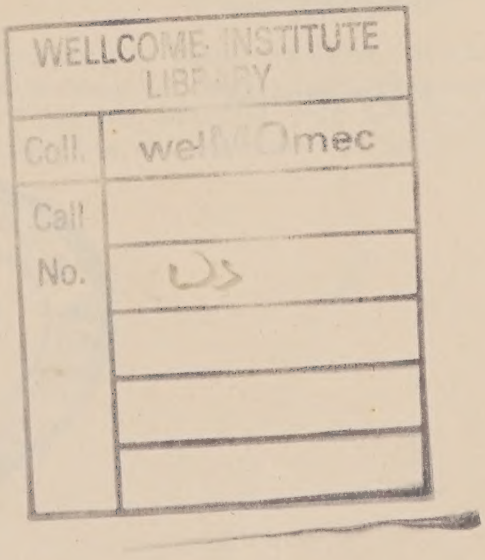
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THE MAPLE PRESS COMPANY, YORK, PA.

To Professors

MACBRIDE, PATRICK, SEASHORE, AND HOUSER

of the University of Iowa,

who have inspired many to search for reality

PREFACE

This book represents the fruit of some fifteen years of teaching child development and child care to women students in the University of Kansas. From a simple, elementary beginning the course inevitably gathered scientific accretion as the sciences of biochemistry, biology, genetics, psychology, and education, by their significant investigations during this period, illuminated the subjects of growth and behavior. Indeed these years have seen the study of the very young child assume a position of pivotal importance in certain branches of the sciences named.

The author has found herself confronted with an ever-increasing need to synthesize (as well as one may who is not a specialist in any one scientific field) current scientific discovery in terms of the phenomena of childhood. In doing this she has quite naturally followed a scheme of unification based upon her own personal philosophy which, at the present time, is rather strongly organismic in trend.

It happens that the period covered by this teaching experience marks the rapid development of the organismic idea. On the one hand, in the fields of biology and neurology, Ritter, Child, Herrick, Morgan, Lashley, and others were apparently establishing the fact of the unity of the organism, the priority of pattern, and the dominance of the whole in growth and in evolution. On the other hand, and coincidentally, Koffka, Köhler, Ogden, Patrick, Burnham, Wheeler, and many others were finding a similar unity of pattern or "wholeness" in behavior. The unification of these two lines of research and the full realization of their implications for child study came to the author only with the reading of the publications of Arnold Gesell, notably *Infancy and Human Growth*, 1928 and Coghill's *Anatomy and the Problem of Behavior*, 1929. Almost abruptly the child stood out as a behaving organism, but an organism integrated within the entire scheme of cosmic organization.

We should be reminded, in this connection, of the debt of all the sciences dealing with living matter to biochemistry. Indeed the use and continued advance of the study of nutrition and the physiology of growth, and the expression of these in behavior, are conditioned upon development in biochemical research. It follows that any intelligent study of the child must borrow its initial interpretations from the science of chemistry.

The author, therefore, makes no apology for presenting heredity, growth, nutrition, behavior, and training in the light of such modern scientific explanation as she has been able to find. The reader, however, is under no obligation to accept the stated conclusions. Indeed, readers uninterested in the scientific content and treatment may completely disregard these and still find a sufficient body of factual data to serve as practical rules of conduct.

The text has been in process of creation for so long a time it is impossible to acknowledge complete indebtedness or fully unscramble sources. Actually every one who has ever read or listened to any part of it has left some imprint within its pages.

The author, however, is under special obligation to the following persons for patient reading and for especially helpful criticism and suggestion: To Viola Anderson and Katheryn Tissue of the Department of Home Economics of the University of Kansas for criticism of the material on foods; to Dr. Mary Swartz Rose of Columbia University for permission to use material on food and for helpful suggestions; to Cora B. Hodson and to Leon Whitney of the English and American Eugenic Societies, respectively, and to Dr. Caroline Hedger of the Elizabeth McCormick Memorial Fund, for reading and criticizing the entire manuscript in its early form; to Dr. Edwin D. Starbuck and Dr. R. E. Currier of the University of Southern California for philosophical criticism; to Dr. Frances Gaw, director of the Child Study Department of the public schools, Seattle, for criticism and encouragement; to Dr. Bert Nash of Kansas University and Dr. T. L. Collier of Washburn College for criticism of the psychological and educational theory; to Dr. O. O. Stoland of the Department of Physiology of the University of Kansas for reading the chapter on Glands of Internal Secretion; to Dr. Josephine Burnham of the Department of English of the Uni-

versity of Kansas for invaluable technical criticism; to my sister, Maud A. Brown, for continuous encouragement and advice.

The author is particularly indebted to the members of a loyal office staff, without whom the book could never have been produced. Emily Ferris, Harriet Stevenson, Alta Gaskell, Louise Irwin, Margaret Chamney, Evelyn Armstrong, and Margaret Roberts all worked faithfully and well upon the manuscript in its various revisions.

To the child care students of former years gratitude and appreciation must be expressed for the way in which they have generously shared their "Exhibit A" babies with newer classes, and for very convincing photographs, some of which appear within.

The reader will become aware of the further indebtedness of the author to certain progressive parents who have contributed pictures and incidents and who have been most generous and cooperative in sharing their rich and satisfying experiences.

Between the lines of these pages also peep the laughing faces of the two whom the author knows the best, as they early made her aware of her need for knowledge and understanding; and who, by their patience with maternal shortcomings and by their never-failing loyalty, have motivated much of the endeavor represented in this book.

To the many publishers and authors who have freely given permission to use poems, illustrations, and quotations, thankful appreciation is here extended..

Last, but not least, mention must be made of the young women who have been the occasion of the writing of the book and who are never-ceasingly both stimulus and inspiration. As they challenge the teaching, go out joyously, with "heads high in the air," and come back, still more joyously, with glorious babies in their arms, their teacher becomes more and more optimistic for the future of the race. She has acquired a great confidence in the present-day college-trained mother, who is the highest expression of maternal efficiency yet achieved.

FLORENCE BROWN SHERBON.

LAWRENCE, KANSAS,
August, 1934.



TO THE STUDENT

The philosophy of this book is so well expressed by Dr. Lois Hayden Meek, director of the Child Development Institute of Columbia University, in her annual report for 1930–1931, that I am repeating her words as the text for what I wish to say to you.

> The movement in child development is an outgrowth of a basic philosophy pertinent to education on all levels. It is based on the principles of integration and continuity. Integration implies that the child reacts as a total organism, that at any one moment of his life what he is and does depends upon his entire physical, mental, emotional, and social development. Moreover, these aspects of child behavior are interacting and interdependent. This philosophy emphasizes that education must be concerned with all aspects of the child, and that a knowledge of physical growth, nutrition, hygiene, emotional development, social development, and mental hygiene is as necessary for the best guidance of children as is a knowledge of mental development, the learning process, and subject matter. Continuity implies that each moment of a child's life is inseparably tied with the past and full of possibilities for the future. Emphasis should be placed upon a genetic study of growth and development for all who are concerned with children of any age.[1]

This book endeavors to present the whole child, from his earliest origins until we lead him to the schoolroom door. In order that you may grasp the import of this statement, and to prevent you from jumping to the conclusion that you are entering upon a series of short courses in chemistry, biology, and psychology, I ask you to spend the first week merely reading steadily through the entire text. Do not stop to worry about details—read to get a bird's eye view of the child in the various aspects indicated. Skip new words; or look them up if you must

[1] Meek, Lois Hayden, *Report of the Director of the Child Development Institute*, p. 3, Bureau of Publications, Teachers College, Columbia University, 1931.

have them to make sense (you will find a glossary in the back of the book). Each day bring up the points which have most interested you for general class discussion. *Spend a week looking at the whole child.* Expecially read the poetry now, and again and again. The poet is a true scientist and often gives us in a magic flash of words the gist of a weighty scientific tome. By the end of a week you should have acquired a lively curiosity as to what the child is made of, where he came from, his mysterious parasitic life within his mother's body, the meaning of his long infancy, the significance of his patterned behavior tendencies; and especially, you should be eager to make the acquaintance of some active child and see for yourself if these things are true.

In other words, we are not studying the child by analyzing his fingers, toes, stomach, and brain (although the endeavor to memorize the content of separate chapters might easily give you this impression) and then trying to construct a child out of the parts. Rather—you are looking at an amazing piece of living machinery—and you are eager to see what makes the wheels go round. You will feel the need of the chapters on chemistry, heredity, and biology! You will go back to them continually merely to satisfy your curiosity.

The time has come when we must live scientifically, rather than empirically, in order to survive; certainly we must do so in order to derive satisfaction from our expanding leisure time. College-trained parents should want more than dogmatic formulas by which to rear their children; indeed they must have more than formulas. They must have the vocabulary with which to read understandingly the wealth of popular scientific child-development literature and current reports on new discoveries. They must have knowledge of the basic factors of behavior and development so that they may make their own formulas to meet the constantly varying and intensely individual problems presented by the life of any child. Parent education is the newest and perhaps the most important extension of the educational system. Do not think you will be in any sense of completeness prepared for parenthood when you have finished this course. You will have only an introduction to a lifelong course of study!

The purpose of this text is to try to give to you, parent or student, the vocabulary and basic scientific insight necessary to read the modern child-development literature understandingly and to enable you to see the place of the child in the modern world. It is especially the hope of the author that it may help you to live joyously with your own children, with an intensified realization of the intrinsic naturalness and beauty of childhood.

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PART I

BEFORE THE CHILD

And a woman who held a babe against her bosom said, Speak to us of Children.
And he said:
Your children are not your children.
They are the sons and daughters of Life's longing for itself.
They come through you but not from you,
And though they are with you yet they belong not to you.

You may give them your love but not your thoughts,
For they have their own thoughts.
You may house their bodies but not their souls,
For their souls dwell in the house of tomorrow, which you cannot visit, not even in your dreams.
You may strive to be like them, but seek not to make them like you.
For life goes not backward nor tarries with yesterday.
You are the bows from which your children as living arrows are sent forth.
The Archer sees the mark upon the path of the infinite, and He bends you with His might that His arrows may go swift and far.
Let your bending in the Archer's hand be for gladness;
For even as he loves the arrow that flies, so He loves also the bow that is stable.

KAHLIL GIBRAN, *The Prophet.*[1]

[1] Reprinted by permission and special arrangement with Alfred A. Knopf, authorized publishers.



CHAPTER I

THE CHILD AND THE UNIVERSE

THE ORIGIN OF LIFE

The Scientific Approach.—The human mind cannot conceive of the beginning or the end, or even of the endlessness of anything—time, space, or matter. Infinity and eternity are alike beyond human comprehension. The most that man can do in his present stage of evolutionary development is to think within an ever widening circle of experience and to make what shift he can to form an organic, meaningful whole or entity out of the relatively small portion of creation of which his senses make him aware. Perhaps the most fundamental characteristic of the human mind and the one which most clearly sets it apart from the animal mind is the compulsion to find *meaning, relationship, unity* in all phenomena experienced by him.

Man's senses (taste, touch, sight, hearing, etc.) tell him all he knows about the universe.[1] It is only since he has learned to reinforce these with mechanical devices, such as the microscope, telescope, scales, test tube, and radio, that it has occurred to him that the universe is full of odors, sounds, colors, substances, and complexities of structure which are still far beyond the range of his possible experience.

Man is, however, continually striving to increase his knowledge of the universe in which he finds himself by using his senses (with the aid of these mechanical reinforcements or extensions) to observe his surroundings and to prove those observations by every test of validity he knows how to make. He calls the results of these tested (controlled) observations *facts*. He proceeds to arrange these "facts" in orderly manner according to

[1] Douglas, A. C., *The Physical Mechanism of the Human Mind*, chap. VIII, The Mechanism of the Space-time Perception, E. and S. Livingston, 1932.

their relation to each other and to previously discovered facts, and he calls this orderly arrangement of facts *science.*

Newly discovered facts of science have little value until their relations to previously discovered facts become apparent. The discovery of a new vitamin means little until it is related to all the other vitamins and its rôle in animal metabolism is ascertained. We conclude that after all it is the relationship of things which most interests us. Professor Einstein and others are even making a new philosophy of the relation of everything to everything else, especially to *time:* They call this comparatively new way of thinking *relativity.*

We shall not here trouble our minds with the complexities of philosophical systems, but our study of the child will have a richness and fullness of meaning proportionate to our ability to see the relation of the child to the universe. We shall accordingly consider briefly the origin and unity of life itself and try to see where the child fits into the Great-Scheme-of-Things according to the light thrown upon this important subject by present-day science. We shall also consider the orderly observations which are being made in the fields of prenatal and postnatal growth and development of the human child, and the relation of these to the management of the preschool years.

The Chemistry of Life.—The study of chemistry is rather suddenly becoming a vitalized subject. It is no longer, for the average student, so entirely a matter of disagreeable odors, reactions in test tubes, troublesome formulas, and much fruitless mental strain; the study of chemistry is becoming a study of the romance and adventure of life: of growth, of heredity, of immunology, of health, of life itself with its manifestations of thought, emotion, behavior, and personality. Chemistry has been defined as the science of the transformation of matter; more exactly one might say that chemistry is the study of changing relationships between structural units of matter. This takes on enormous personal significance when we consider that even in our most casual social relationships we produce definite chemical changes in each other's bodies; that every thought produces or is accompanied by chemical changes in brain cells. Think upon the import of the fact that one may address to a companion a remark which may alter every chemical reaction in his body, throw his

glandular mechanism into new tensions, affect his digestive metabolism, and thus alter his entire pattern of behavior! Chemistry has become a fundamental science of life and living. Man is now studied largely as a behaving, biochemical organism.[1] Even psychology and education are becoming in a very real sense biochemical sciences.

Since every aspect of living activity involves chemical reaction, our study of the origin and development of the child will begin with a brief review of the chemistry of life. How the universe as known to us came into existence is as yet a matter of pure speculation. Science begins its real investigations with the 92 elementary substances which alone, as far as determined at the present time, enter into the composition of the earth and of all other celestial bodies. Not only are soil, rock, water, and all other inert substances made up exclusively of these *elements* (and possibly others which may yet be discovered), but of far greater interest to us is the fact that living matter also is made up entirely from these same elements, and a rather limited number of them at that.

Spectrum analysis[2] of light rays from other cosmic bodies fails to reveal any substances other than those known to enter into the structure of our own earth, but the sun does contribute in addition something which seems to be essential to the activation in these elements of the chemical changes which result in life. That something is light.[3]

The story of the origin of life upon our planet, as generally accepted by scientists at present, runs somewhat as follows. Some think that first there was a nebular, vaporous mass of elementary substances (as many as there ever will be in all probability); others think there was a hard mass, possibly broken from the sun itself. Eventually there was, in either case, a hard

[1] Nash, Jay B., editor, *Body-mind Relationships*, chap. VI, Life as a Biochemical Mechanism, by Malcolm E. Little, A. S. Barnes & Company, 1931.

[2] All chemical substances when heated reflect light and show characteristic bands of color and shadow when passed through a spectroscope. This is a certain and delicate test when applied to the composition of even distant stars and planets.

[3] Fasten, Nathan, *Origin through Evolution*, pp. 38–39, F. S. Crofts and Company, 1929.

central core surrounded by water and gaseous atmosphere.[1] By and by the water evaporated sufficiently to expose portions of the earth beneath, which wrinkled as it cooled, producing surface irregularities, and for long ages the sun with its potent ultra-violet rays shone upon shallow quiet pools in certain favorable places where the water was highly impregnated with elementary substances in solution in inert lifeless crystalloid and amorphous forms. Gradually *crystalloid* or inert matter became transformed into complex *colloids*. The creation of colloids was the first step toward the formation of life.

Our subsequent discussion of the origin of life, of growth, heredity, nutrition, etc., will be more clear if we review here a few of the most elementary facts of physical and chemical science. It will be necessary in this connection constantly to bear in mind that modern science, as has been said, is revealing the existence of much that is beyond the range of our finite human senses. Indeed, the human imagination can scarcely grasp the range and potency of substances and forces, both incredibly small and incredibly large, which we are asked by modern science to accept as proved and probable.

Elements.—The 92 elementary substances with which we must do our chemical thinking were until recently supposed to be undecomposable. It is now believed that slow disintegration of certain of the radioactive elements is taking place in nature whereby they are transformed into other elements (for example, into lead); this sort of transformation may be going on all the time in interplanetary space. Experimentally, also, atoms of elements have been exploded in the laboratory, producing new atoms of other elements, such as hydrogen. However, for all practical purposes (as yet), the elements may still be considered to be undecomposable.

Atoms.—The smallest component structural particles into which an element can be divided still shows all the characteristics of any mass of the element. This structural unit of an element is called an *atom* (from *atomos*, indivisible).[2]

[1] Lane, H. H., *Animal Biology*, chap. XVII, Paleozoology, P. Blakiston's Son and Company, 1929.

[2] Russell, Bertrand, *The A. B. C. of Atoms*, E. P. Dutton & Company, Inc., 1929.

Electrons and Protons.—Science has always felt the need of reducing all matter to one basic substance. The ancient alchemists (the first chemists), for example, thought it should be possible to transmute all substances into gold. Science now seems to have succeeded in reducing all material phenomena to *electricity*, which is now conceived of as consisting of two opposed and equally balanced ultrainfinitesimal units called positive and negative corpuscles or *protons* and *electrons*. These corpuscles have a powerful attraction for each other and tend to leap incredible spaces if their neutrality or balance is disturbed by the accumulation of a great many protons at one point and electrons at another. This flow of free protons or electrons from one point to another is known as positive or negative electrical current. This is a force of tremendous potency even in the inconceivably minute fractions existing in the structure of an atom.[1]

An atom is now conceived of as being made up of protons and electrons combined and arranged in a manner peculiar to the particular element, giving it its specific character, and always so proportioned that the protons and electrons in a given atom neutralize each other (except in the case of *ions*, *i.e.*, atoms which have lost or gained one or more electrons, thus making them positive or negative electrically). The protons are always found in the center or nucleus of the atom. Recently a third kind of electrical body has been postulated, called a *neutron*. This seems to consist of a proton and an electron which are very firmly united with each other, and found with other protons within the nucleus. The rest of the electrons required to balance the positive charge of the nucleus are arranged in a very precise and definite manner and are supposed to revolve in orbits about the nucleus. Certain of the external electrons of the atom are less firmly attached than are the others, and may become attracted to the protons in the atoms of another kind of element. Chemical union between the unlike atoms may then take place and a *compound* may be formed: or the atoms may preserve their individuality and merely become "ionized," and are then known

[1] PLUNKETT, C. R., *Outlines of Modern Biology*, chap. I, Matter and Energy in Living Forms, Henry Holt & Company, 1930.

as ions of the particular substance, for example "sulphur ions" or "ionized iron."

Molecules.—When chemical union occurs between the electrons composing the atoms of the same or of different elements it does so in a very precise and predictable way as expressed in the mathematical formulas which make the study of chemistry so exact a "discipline." The result of such an arrangement of atoms in a new and definite pattern is the formation of *molecules;* the molecules collectively form a compound, which is a new substance having different characteristics from those of any element entering into its formation. Hydrogen and oxygen atoms, for example, mingle freely in ordinary air without affecting

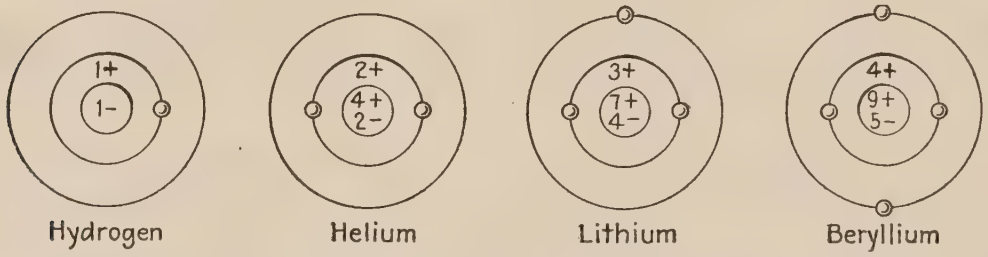


FIG. 1.—Diagram of atomic structure. The net positive electrical charge in the nucleus is the same as the positive charge of the electrons rotating (supposedly) about the nucleus. (*After Bohr.*)

each other (this is a *mixture*). Under certain circumstances, however, two atoms of hydrogen unite very firmly with one atom of oxygen (H_2O) and a molecule of water is formed. Water is unlike either hydrogen or oxygen or any other compound of these. The peculiar force or attraction which causes atoms to form patterned molecules is called *cohesion.* The same force tends to hold molecules together to form masses of individual compounds.

In some elements the combination of protons and electrons in the atoms is very stable and they will not easily enter into molecular formation with the atoms of other elements. In other elements the atoms are unstable in structure, and these elements are highly susceptible to chemical change.

Molecules are constantly in motion, even in very dense solids; also, as we have seen, the electrons circulate in perpetual motion within atoms. Nothing in the universe is static, or still, although some things may seem to be so to our limited senses.

In addition to movement within the atom, and movement of the atom and molecule (and micella of colloids, as we shall presently see), there is another curious force opposed or in contrast to cohesion, called *diffusion* which impels atoms and molecules under certain circumstances to space themselves at equal distances within elastic media such as liquids or gases.

Protons, electrons, atoms, and molecules have not been seen. They are terms invented by science to account for chemical and physical phenomena. They seem to do this to the satisfaction of all scientists. So fully do these units account for the observed changes in matter that even the size of these bodies is computed with great exactness and agreement. It is accepted that, although the electrical charge of an electron and a proton exactly neutralize each other, the electron is exactly 1,845 times the size of the proton. A dime is three thousand million, million, million, million times the size of an electron. If the proton in an atom of hydrogen (the simplest element known, having only one proton and one electron) were enlarged to 1 millimeter ($\frac{1}{25}$ inch) in diameter, the electron which circulates in an orbit about it would be about 6 feet in diameter and the circumference of its orbit would be 15 miles from the proton in the center.[1] It has been estimated that if all the protons and electrons composing the atoms in a single human body were compressed so as to leave no vacant space between them they would occupy less volume than is indicated by the head of a pin.[2]

We are told that one drop of water contains molecules to the number of 2×10 raised to the twenty-first power. Stieglitz says: "To grasp the meaning of this number 2×10^{21}, consider that there are nearly 2,000,000,000 people on the face of the globe and that if each one of these were to count three molecules of water per second, it would take all of the inhabitants of the earth something over 10,000 years to count the molecules in one drop of water."[3] Who wants to undertake to count the atoms and electrical corpuscles within said drop of water!

[1] Kent, Norton A., *Modern Scientific Knowledge*, chap. X, The Newer Physics, Ronald Press Company, 1929.

[2] Nash, Jay B., editor, *Mind-body Relationships*, chap. V, p. 79, Life as a Biochemical Mechanism, by Alexander Jerome, A. S. Barnes & Co., 1931.

[3] Stieglitz, Julius, *Chemistry in Medicine*, chap. I, The Significance of Chemistry, The Chemical Foundation, Inc., 1928.

Here, in something less than the proverbial nutshell, is epitomized the basic mechanism of the various phenomena of life which are to be considered in this book; also the basic mechanism of all the amazing inventions and accomplishments of industry, commerce, and creative science. Chemistry is indeed the science of sciences.

Water.—To return to our cooling earth, we find that the most important of the elements from the standpoint of the study of life are only four: oxygen, hydrogen, carbon, and nitrogen. At a certain stage we find that already a great amount of oxygen and hydrogen atoms have combined to form water, a great deal of water, still covering most of the hardened core of the earth.

Solution.—Water is of peculiar interest because it has the very important property of holding the atoms and molecules of many other substances in "solution." This means that the atoms or molecules of the solute (the substance dissolved) tend to arrange themselves at equal distance from each other throughout the entire extent of the mass of water (or other solvent[1]) by *diffusion.* If there is a small amount of water the particles of solute will be close together but equidistant from each other, and we say the solution is "concentrated." If no more solute can find space for its molecules or atoms and the surplus falls to the bottom we say the solution is "saturated." If more water is then added the particles will spread out, like soldiers changing from close formation to open-space formation, and the solution will be less concentrated, but it will still be uniform throughout. In a true solution the substance dissolved will not separate or settle.

No one yet knows quite what happens when substances dissolve. It is not a chemical union, since the atoms or molecules of the solute and the molecules of the solvent remain respectively unchanged.

Substances in solution enter much more readily into chemical union with other substances than when in a dry state. Hence solutions, especially in water, are important in all chemical reactions, including those involved in living cell activity.

[1] Some substances such as fats dissolve only in alcohol, ether, or solvent other than water. Water is the great and almost universal solvent, however, hence its use for illustration.

Water has another important function, and that is the rendering of substances in solution highly susceptible to a form of electrical change known as *ionization*.

Emulsion.—Certain substances, such as oil, which do not dissolve in water, may be made to remain suspended uniformly throughout the water in minute drops or particles if soap or sodium carbonate or any of certain other substances is dissolved in the water and forms a film about the droplets of oil. This is known as an *emulsion*. Protoplasm sometimes assumes the structure of an emulsion in which the droplets are minute units of watery solutions of various minerals enclosed in colloidal films.

Osmosis.—If two solutions of the same substance or different substances, of unequal density or concentration, are separated by an animal or plant membrane (which is *semipermeable*), such as the wall of the intestine or a blood vessel or the surface of a cell, which will allow the passage of the small molecules of water but not larger molecules of solute, the water will filter from the weaker to the stronger solution until both are of the same concentration. This is a form of diffusion known as *osmosis*. Sometimes there is exchange of solutes when the molecules are small enough. This is what takes place through capillary and cell membranes in the process of body metabolism when the blood stream takes up waste from and gives up food to the tissue cells. All the body fluids are watery solutions of many kinds of substances, which are constantly filtering through semipermeable membranes.

Oxidation.—Oxygen is the most abundant of the elements, constituting about one-half of the earth's mass and one-fifth of the air. We have just seen that oxygen in combination with hydrogen in the form of water plays an important rôle in chemical change. Oxygen also enters into the very wide range of chemical changes called *oxidation*. Growth, decay, corrosion, and combustion involve oxidation. All living organisms obtain the energy necessary for life processes from the oxidation (burning) of carbon compounds. Combustion or oxidation will not take place in the entire absence of moisture in the substances or in the air. Oxidation takes place readily if only a very small amount of water is present and, as is well known, will not occur if there is too much water. Just what takes place in oxidation is not entirely clear.

The release of electrical energy with the shifting of the electrons in the oxygen atom is involved. Oxidation may take place very slowly as when iron rusts away, or very rapidly as when wood is burned, or when lactic acid is oxidized by the oxygen in the red blood corpuscles in the capillaries of an athlete's muscle.

So important is oxidation in plant and animal economy that special organs of respiration and circulation of many and interesting varieties are formed throughout the entire range of evolutionary forms for the purpose of supplying a steady and uniform fund of oxygen to the living structures.

Carbon is of interest to us chiefly because of the fact that certain compounds of carbon together with the water molecule, H_2O, form the complex *carbohydrates*, and, with other proportions of hydrogen and oxygen, form *fats*. The carbohydrates and indirectly the fats (and, to a very slight extent, proteins) supply all living organic matter with fuel for oxidation, thus producing energy, which may be expended in action or "behavior" and in maintaining bodily warmth.

Nitrogen, the fourth member of the quartet of elements which take leading places in the chemistry of life, is especially important to the structure of the substance-of-life, *protoplasm*. Nitrogen is essential to the composition of cell nuclei, and is the vital constituent of *protein*, a most interesting type of compound which plays the star rôle in the drama of vital phenomena. The relative amount of nitrogen in the body is not large, but it is of the greatest importance. Nitrogen is in itself an inert substance which supplies about four-fifths of the bulk of common air.

In addition to these, certain other elements are found in the human body as indicated in the table shown on page 13.[1] These are each and all indispensable, although only minute amounts seem to be required. Copper and manganese are recent additions to this list. Other elements may be found present and indispensable as investigation proceeds.

Forms Assumed by Elements.—As we return to the story of the origin of life it will be necessary to consider the fact that the elements of the earth may assume several forms. The original was possibly *amorphous* (without form), all particles of a given

[1] SHERMAN, H. C., *Chemistry of Food and Nutrition*, p. 236, The Macmillan Company, 1932.

element being alike. When inorganic solutions dry out, through evaporation, the atoms tend to arrange themselves in geometrical designs, some of them of bewildering intricacy and beauty, known as *crystals*. These forms are characteristic for the individual substance. Such substances are called *crystalloids*. Crystalloids are inert and unchanging; salt crystals form today exactly as they were formed in beds of evaporating sea water when the world was very young. We may assume that there was nothing

Element	Approximate Percentage in Body
Oxygen	65.0
Carbon	18.0
Hydrogen	10.0
Nitrogen	3.0
Calcium	1.5
Phosphorus	1.0
Potassium	0.35
Sulphur	0.25
Sodium	0.15
Chlorine	0.15
Magnesium	0.05
Iron	0.004
Iodine	0.00004
Copper	Very minute amounts
Manganese	Very minute amounts
Zinc	Very minute amounts
Fluorine	Very minute amounts
Silicon	Very minute amounts

upon or within the earth when the waters first receded except elements and compounds in solution or in crystalloid form.

Ions and Ionization.—Reference has been made to the fact that certain atoms may lose or gain electrons from their surface. When an atom loses one or more electrons it becomes *positively charged*, that is, it has a vacancy, hence a powerful attraction for other free electrons. It is then said to be *ionized* and has become a *positive ion*. When an atom takes on extra electrons it repels other free electrons and is said to be a *negative ion*.

When we recall the minute character of an electron it is difficult to realize that the addition or subtraction of even one electron from each atom of a substance may radically change its character. Copper is reddish gold in color. Weathered or ionized copper,

which has become ionized through exposure to moisture (H_2O), is bluish green in color. An atom may be harmless and its ion poisonous or *vice versa*. Ions are unstable and highly soluble in water; hence they perform an important function in the flexible and rapid chemical changes taking place in organic structures, which are so largely composed of water.

Acids and Bases.—Among the ions of utmost importance in organic chemical relationships or balances are the hydrogen and hydroxyl ions. The hydrogen ion is present in all acids; the degree of acidity is dependent upon the proportion of, or concentration of, hydrogen ions (H^+) in the solution. If OH^-, the hydroxyl ion, is present in the solution, the reaction will be basic or alkaline. If there is equal concentration of hydrogen and hydroxyl ions the reaction will be neutral.[1] The symbol for the degree of acidity is pH and the same with minus sign is the symbol of alkalinity.

The rôle of ions in body chemistry is exceedingly important. The normal beating of the heart depends upon nicety of balance between the calcium and sodium and potassium ions present in the blood. The cytoplasm of a cell is acid, the nucleus alkaline, and the normal acid-base balance between the structural parts of a cell and between tissues and surrounding fluids is specific and fixed.[2] Calcium ions aid in regulating the clotting of blood. Protoplasmic colloids adsorb more water in the presence of acids, hence a disturbance of the normal chemical reaction of the body through the presence of too many hydrogen ions may lead to accumulation of fluid in the tissues, or "dropsy." This is, in part, the reason the tissues about an insect bite swell or enlarge. The venom is acid and reacts with the fluids and colloids in the tissues.

[1] An *acid* may be further defined as a substance which usually has a sour taste, which will give up one or more of its hydrogen atoms to a metal, and which turns litmus paper red. *Bases or alkalies* contain hydroxyl combined with a metal. They are usually soapy in texture, bitter in taste, and turn litmus paper blue. When acids and bases combine, the H in the acids combines with the OH in the base to form water, H_2O, and the residue is a *salt*.

[2] Nash, Jay, B., editor, *Mind-body Relationships*, chap. VII, p. 97, The Body as a Biochemical Mechanism, by Robert Chambers, A. S. Barnes & Co., 1931.

As we proceed to the discussion of metabolism in pregnancy and childhood we shall learn more of the chemistry of life as embodied in delicate reactions between acids and bases.

Colloids.—As the sun shone for long ages upon shallow quiet pools certain crystalloids began to assume a peculiar structure which has come to be called *colloidal.* This was the first step toward organization of the elements into living forms. As the ages passed many elements assumed colloidal form. Nature takes much time about all this—eons are but moments in her sight. She has now, however, produced a colloidal organism called *man* who can, with his colloidal brain, direct the speedy transformation of many crystalloid elements to colloidal form within his experimental laboratories. It is now believed that all elements may assume either crystalloid or colloid form according to conditions to which they are subjected.

The characteristics of colloids are exceedingly complex and in many points are not yet well understood. The peculiar arrangement of the colloidal units in the formation of protoplasm is significant. When a fluid comes into contact with a denser surface some of the fluid tends to adhere to the surface; the reason for this phenomenon is not yet known. The greater the surface the more fluid will be *adsorbed* or remain adherent.[1] If one puts a small amount of fluid into a large vessel it may all cling to the inner surface or be adsorbed.

It appears that the atoms or ions or molecules in forming colloids become aggregated in masses larger than those of molecules. These are called *micellae* (meaning "crumb-like" bodies). They are too large to pass through semipermeable (living) membranes and therefore cannot be absorbed in osmosis through blood-vessel walls.

Micellae arrange themselves in various patterns, reticulate, filamentous, honeycombed, bubble or emulsion-like, etc. All these arrangements tend greatly to increase the surface available for adsorption. Thus a protoplasmic cell is not a sac of fluid, but a clever arrangement of micellae designed to adsorb or hold with its greatly increased surface contacts the greatest possible amount of water in which various crystalloid substances are held in solu-

[1] A substance is *ad*sorbed when it adheres to a surface, it is *ab*sorbed if it penetrates the structure and becomes incorporated in it.

tion. The *water of adsorption* in living cells is sometimes called *bound water* or *living water*. The collective force of the adsorptive surfaces in growing matter as they take up watery solutions from their environment is tremendous and plays an important part in the phenomena of life. This is the force in the growing root which splits the rock. A micella is larger than a molecule but is still submicroscopic in size. However, the shadows of these colloid units are now discerned with that remarkable instrument, the ultramicroscope. In order that we may tease our imagination with trying to understand the significance of the apparently simple mechanical arrangement of colloids in the structure of protoplasm, let us consider that a cube measuring 1 centimeter on

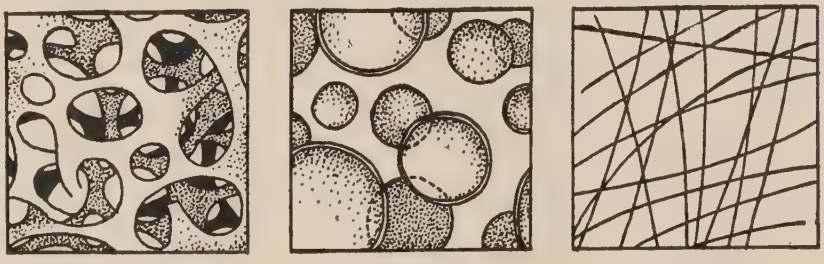


FIG. 2.—Various arrangements of protoplasmic colloids.

the edge has a total surface of 6 square centimeters. If it is subdivided so that the new cubes are 0.1 millimeter on the edge there would be 1,000,000 new cubes and the surface would be increased to 600 square centimeters. If this subdivision could be continued until the cubes were 0.001 mμ on the edge there would be 1 nonillion (10^{30}) cubes and the total surface would be 6 square kilometers, equivalent to 1,482.6 acres, or $2\frac{1}{3}$ square miles.[1] That such attenuation is possible in protoplasmic structure is evident from the fact that even these minute cubes are 1,000 times the theoretical size of the electron.

Some one has said that if a tennis ball were divided into colloidal particles the total surface area of these particles would cover twenty tennis courts.[2]

[1] CLEVELAND, F. A., editor, *Modern Scientific Knowledge*, chap. XIII, p. 216, Application of Colloidal Science to Biology, by Ralph N. Maxson, Ronald Press Company, 1929.

[2] MACLEOD, ANNIE LOUISE, *Chemistry for Nurses and Students of Home Economics*, p. 45, McGraw-Hill Book Company, Inc., 1928.

Adsorption is perhaps the most important property of protoplasm. The micellae of various colloidal substances seem to have a *selective attraction for specific solutions* which explains, in part, protoplasmic specificity (individuality) and the phenomenon of growth whereby the colloids of a living cell select from their fluid environment exactly the materials needed to maintain their structural integrity.

When crystalloid substances become colloidal, they assume glue-like, viscid, or gel-like consistency chiefly by virtue of adsorptive action. Colloids may exist in solid, liquid, or gaseous form, although semisolidity is their usual state. The complex structure of colloid-compounds brings many kinds of atoms and molecules, liquids and gases together in intimate structural contact; all of these being respectively and individually in motion (see page 8), the result is a curious mass-movement called *Brownian movement*, which tends to keep the colloidal particles or micellae evenly dispersed throughout the fluid medium. This is comparable to the diffusion of solute throughout a solution (see page 10).

As has been said, colloidal micellae are too large to pass through living membranes. Most nutritive substances are colloidal; therefore they must be broken down into crystalloids and simple organic substances and dissolved in body fluids before they can be utilized by the various tissue-cells of the organism. This is the chief function of the process of digestion.

In general, colloids are dynamic and unstable and are constantly giving off and taking up substances from their environment, but always selecting in such a manner as to maintain the integrity of their individual composition or pattern.

The study of the colloidal form of matter has become a separate and distinct science. "It is more than a branch either of physics or chemistry. It has expanded until it occupies a territory all its own. It is a broad fundamental science dealing with one of the five states of matter."[1]

Protein.—The most interesting and important and the most complex of the organic colloids is *protein.* Proteins contain carbon, hydrogen, and oxygen. Carbon is a very unstable element, combining easily and in a great many ways with other

[1] MAXSON, *op. cit.*, chap. XIV, p. 242.

elements, notably combining with oxygen and hydrogen to form carbohydrates and lipoids (fats). Apparently all proteins contain sulphur, and many contain phosphorus. To these elements is added nitrogen. From these the structural units of the proteins are made—the *amino acids*. There are 22 amino acids the chemical formulas of which are known. Most of the amino acids can now be made synthetically in the laboratory. The synthetic creation of proteins from these has not yet been successful. Amino acids are frequently called the building bricks of the proteins. Proteins are colloidal combinations of amino acids. These combinations are far from simple when chemically considered. Protein molecules have the greatest molecular weight and the most complex formulas of all known compounds, so complex, indeed, that most if not all formulas are yet in doubt. The formula for hemoglobin, one of the blood proteins, for example, is assumed to be $C_{758}H_{1203}N_{195}S_3FeO_{218}$ with a molecular weight of 16,669!

One might naturally conclude that 22 amino acids, even with complex structure, would combine to form a very definite and manageable number of specific proteins. When the mathematicians have finished combining 20 figures in all possible ways our poor human imagination has sustained another shock as we have to try to realize that the possible combinations of 20 amino acids (22 are now known) run into millions of millions. There may be, therefore, almost literally innumerable varieties of proteins, particularly in view of certain structural differences in atomic arrangement which have not been mentioned. It is now believed that differences in the proteins entering into the structure of all living organisms chiefly account for the specific phenomena of life-processes, including hereditary differences, immunity, vital functions such as metabolism, glandular behavior, perhaps intrinsic differences in temperament and character itself. Newman says, "The differences between individuals are, in the last analysis, largely dependent upon the differences inherent in their specific proteins."[1]

The possibilities of an inconceivable number of constitutional differences in any given protein are instanced in the fact that the serum

[1] Newman, H. H., *Outlines of General Zoology*, p. 42, The Macmillan Company, 1926.

albumin molecule may, as has been estimated, have as many as one thousand million stereoisomeres [substances differing only in the spacing and arrangement of atoms in the molecule]. Other of the higher proteins may each have a similar number. . . . It can readily be conceived how, primarily by differences in chemical constitution of vital substances, and secondarily by differences in chemical composition, there might be brought about all of these differences which serve to characterize genera, species, and individuals.[1]

Proteins being complexes of amino acids, most of the twenty or so of which have been found in proteins being found in every protein, the possible number of distinct and different proteins that might exist in nature is enormous, and entirely sufficient to explain what we know of the range of immunological specificity. Abderhalden has calculated that twenty amino acids could form at least 2,432,902,008,176,640,000 different compounds, and this without including the enormously greater number that might be made by varying the proportion of the different amino acids in a single protein. Certainly this fact of itself is strong support for the hypothesis that immunological specificity, and most of the other features of biological specificity, such as heredity, must depend on the proteins. They alone could furnish the infinite variety of modifications found in the multitudes of different living creatures and in their life processes. And, moreover, we find that to guard the specificity of all living forms, elaborate provisions have been taken to see that foreign proteins do not enter the cells or the circulating fluids until they have been robbed of their foreign character, through digestive splitting into simple amino acid complexes that lack specificity.[2]

Protoplasm.—After certain colloids became organized into proteins it is assumed that under the continued stimulus of the ultra-violet rays these proteins and other substances became organized into the still more highly complex substance, *protoplasm, which somehow carried with it the property of life.* Professor Lane says protoplasm is "not the name of *a* chemical compound, but rather of any mixture of substances which manifests life."[3]

Protoplasm consists of colloidal proteins, fats (lipins) and carbohydrates, plus a variety of inorganic minerals or salts, plus water, plus subtle and mysterious enzymes, catalysts, or

[1] Reichert, E. T., *A Biochemic Basis for the Study of Problems of Taxonomy, Heredity, Evolution, Etc.*, Part I, Carnegie Institute, 1919.

[2] Wells, H. Gideon, *Chemistry in Medicine*, chap. IX, p. 573, Immunity, The Chemical Foundation, Inc., 1928.

[3] Lane, *op. cit.*, pp. 26–32.

activating agents. Newman includes vitamins and hormones as possible essentials.[1] All these are arranged, or organized, in the manner described under Colloids, an arrangement which makes complex and rapid but remarkably specific chemical changes possible within the protoplasmic unit, the cell.

If the numerical possibilities in varieties of protein stagger the imagination, what shall we say about protoplasms when we consider that several or many proteins may appear in the structure or composition of one protoplasmic organism? The specificity of the protoplasms seems to depend chiefly upon their protein components and the patterns in which these are combined.

It probably took Nature millions of years to achieve the transformation of matter from crystalloids to organic colloids. This can now be done in the test tubes of any appropriately equipped laboratory. The energizing of these substances, the imparting to them of the gift of life, is still the baffling problem, the great mystery, although it is no longer unthinkable that science may yet do even this.

If proteins are essential to life we may say that protoplasm *is* life, for it became energized. Perhaps it is more nearly correct to say that the organization of protoplasm somehow in itself created living energy. It became endowed with the ability to regulate its own inner activity and outer responses in such a way as to maintain its chemical pattern, individuality, or integrity, and to increase in bulk or *to grow;* it became able to perpetuate itself, or *to reproduce.*[2]

Catalysts and enzymes are substances which in minute amounts produce a great deal of chemical activity among other chemical elements without themselves participating in the chemical change or suffering any change or diminution in their own character or amount. The entire amount of activating agent can be recovered unchanged at the end of a violent chemical reaction. *Catalysts*

[1] Newman, *op. cit.*, pp. 41–43.

[2] W. B. Cannon, in *The Wisdom of the Body*, p. 23, W. W. Norton & Company, Inc., 1932, says: "Somehow the unstable stuff of which we are composed had learned the trick of maintaining stability. . . . The use of the word learned is not unwarranted. The perfection of the process of holding a stable state in spite of extensive shifts of outer circumstances is not a special gift bestowed upon the highest organism but is the consequence of a gradual evolution."

(from a Greek word meaning *to loosen*) are chemical elements which under certain conditions produce active chemical change in inorganic substances. Aluminum acts as a catalyzer under various conditions, as when in a cigar lighter the aluminum wire causes ignition of the alcohol vapor when snapping the lighter exposes the vapor to air.

Living or organic catalysts, called *enzymes*, are found in all living cells, tissues, and organs, and seem to be essential to protoplasmic function. Enzymes are elusive since they are destroyed by analytical procedures, just as the essential secret of living protoplasm escapes analysis. Enzymes are involved in all biochemical changes in living protoplasm. They may be separated or isolated as in the case of rennin or pepsin, but their exact chemical composition remains unknown. It appears that they are colloidal in character and that they contain protein, but even this is rather uncertain. There seem to be infinite numbers of enzymes, and much is known as to their behavior and importance, but the full significance of their rôle in life chemistry is one of the many alluring revelations reserved for the future.

The Continuity of Life.—We have seen that one of the interesting facts about living things is that they are made of nothing but certain combinations from among a few of the 92 elements of the earth. We are literally made from the dust of the earth, colloidal dust plus life-force from the sun, or *dust plus a plan!* The next striking fact is that this life-force, whatever it is, by virtue of its ability to make new organisms similar to itself out of the dust of the earth, becomes potentially immortal in time and space. Given a perfectly favorable environment there is no reason why any living thing should ever stop its self-perpetuation within the unthinkable ranges of infinity and eternity.

Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, in 1912 succeeded in placing a few embryonic chick-heart cells (embryonic heart cells retain many of the properties of one-celled organisms and contract rhythmically before being connected with the nervous system) in conditions completely favorable to their growth and reproduction. These conditions have been kept uniform and favorable, and the progeny of these cells are still contracting rhythmically, growing, and reproducing. At the end of 16 years (1928) Dr. Carrel reported that if all the

progeny of these cells could have been permitted to survive (it has been necessary to divide the mass every 48 hours during all these years), they would then fill the solar universe, and that he saw no indication that they would ever cease as long as conditions could be kept favorable. He says, "Time has no action whatever on these tissues. They are immortal."[1]

Wilder says:

> Protoplasm is at once the most enduring and the most easily destroyed of substances; its molecules are constantly breaking down to furnish the power for the manifestations of vital phenomena, and yet, through its remarkable property of assimilation, a power possessed by nothing else upon earth, it as constantly builds up its substances anew from the surrounding medium, usually in excess of that lost by disintegration, and possessed of qualities identical with those of the parent. . . . Through this power of assimilation there is a constant encroachment of the organic upon the inorganic, a constant attempt to convert all available material into living substance, and to indefinitely multiply the total number of individual organisms.[2]

It is conceivable that any form of life, under perfectly favorable conditions, might eventually absorb or fill the universe at least to the point at which it had consumed or assimilated the entire stock of suitable chemical elements. The simpler organisms require simpler conditions and would accomplish this more speedily, as we have seen in Carrel's chick-heart cells.

Lull of Yale computes that if just one paramecium (barely visible to the naked eye) could be permitted to produce and survive to the 9,000th generation there would not be room for a star in the sky. The universe would be solid paramecium.[3]

Jewett computes that the great great grandchildren of one oyster, if all offspring survived and reproduced at their normal rate, would provide a heap of shells eight times the size of the earth.[4]

[1] Carrel, Alexis, The Immortality of Animal Tissue and Its Significance, *Proceedings of the Third Race Betterment Conference*, Race Betterment Foundation, Battle Creek, Michigan, 1928.

[2] Wilder, H. H., *The History of the Human Body*, pp. 1–2, Henry Holt & Company, 1923.

[3] Dorsey, William A., *Why We Behave Like Human Beings*, p. 99, Harper & Brothers, 1928.

[4] Jewett, F. G., *The Next Generation*, Ginn & Company, 1914.

We thus see that a tremendous *will-to-live* or instinct of survival, is the outstanding characteristic of living things. This will-to-live, or struggle toward immortality, operates through the ability of protoplasm, functioning according to specific organic law, to appropriate and transform and use its environment toward this end. Remembering this may help us to understand the insatiable greed of the child for experience. Every vital unit in his incredibly complex organism is reaching out to conquer the universe!

The Limit of Life.—For some inscrutable reason all life cannot survive and nothing alive today, at least in its present form, will see immortality. Incessant, inexorable chemical flux and change is the essence of the creative plan which seems to be driving matter toward some distant cosmic purpose. Conflict with environmental conditions and conflict between organisms inhere in the situation. This conflict leads to change in life form, involving *death* and *evolution.*

No life form is yet able successfully to cope with environment except through its ability to create progeny. Every organism is created with a self-limited tenure of life. Its protoplasm is doomed to lose its dynamic property of assimilation; its battery runs down; its colloids again become crystalloids. It is returned to the earth from whence it came. "We are born in death."

Summary.—Everything is *related* to everything else. Life is so closely related to the inanimate elements of the earth that it arose from them. Even we, who believe we are of the highest type of life yet to appear, are literally made from the "dust of the earth," and will return to it when something unfavorable in our environment breaks the scheme of unity which makes of each of us a functioning organism, and when our body protoplasms become unable to assimilate environment and maintain their specificities.

Every unit of matter yet conceived by science is in motion; this holds true from electrons, atoms, and micellae to planets and stars. *Movement involves time.* Hence the relatedness of everything to everything else changes momentarily as *time* passes. Time must be reckoned as a factor in all phenomena of life. Time is one of the "dimensions" of "reality."

The number of chemical elements (indivisible substances) which are known to participate in the organization of living

forms is not large, some 18 in all, and of these 4 play the leading rôles: hydrogen, oxygen, carbon, and nitrogen. Hydrogen and oxygen form water, which makes up the larger part of the mass (70 to 85 per cent) of protoplasmic structures. Water is the universal solvent which renders the other elements available for the rapid chemical changes necessary in life processes. Hydrogen, oxygen, and carbon form the fuels for living energy—the numberless forms of carbohydrates and fats. These become organized in a peculiar manner called colloidal, which provides an incredible amount of surface for the adsorption of solutions of the remaining elements known to enter into living structure. Nitrogen is added in the form of the amino acid nitrogen-carriers. All these become organized to form protoplasm, which is living matter.

The factors which seem to give specificity to living organisms are their proteins. The 22 amino acids can form literally millions of millions of varieties of proteins, enough to account for all cell differences found in nature, and for the forms of behavior of these, such as infection, immunity, growth, reproduction, heredity, etc. Proteins are therefore interesting and important substances of which we shall hear more and more.

The amazing thing science asks us to believe about the structure of the elements of the universe is that they are formed from units of positive and negative electrical force in the form of corpuscles which are called protons and electrons (not that anyone yet can define electrical force!). The scientists ask us to believe this because they have constructed mathematical formulas for relationships between these which do seem to account for all the atoms of all the elements and all the compounds of these into molecules, micellae, and colloids. Thus far man can go in his laboratories. When it comes to touching these off with the spark of life, he is still baffled. Nature has somehow done this, apparently through the potent rays of the sun, and has raised up a colloidal organism, called man, who with his colloidal brain may yet wrest even this secret from Nature (which is merely one of the terms we use to designate the Unknown Planning Force), since it seems to be in the Scheme-of-Things that man shall rise to higher and ever higher levels of organization until he has accomplished immortality. Perhaps on other worlds the gamut has been run from elemental electric force to immortality—who knows?

Do we not need to have a fairly clear notion of the origin and continuity and trend of life in order to understand a child? Does it not modify our attitude toward him and add interest to our study of him?

Does it not add dignity and meaning to life when we get a bird's-eye view of an unfolding cosmic plan which seems to integrate all phenomena of creation into one organic whole?

We are here permitted to present Mr. Wheelock's fine poetical expression of the facts which have been discussed in this chapter. It might have as an appropriate subtitle "Dust Plus a Plan."

Earth

Grasshopper, your tiny song
And my poem alike belong
To the dark and silent earth
From which all poetry has birth;
All we say and all we sing
Is but as the murmuring
Of that drowsy heart of hers
When from her deep dream she stirs:
If we sorrow, or rejoice,
You and I are but her voice.

Deftly does the dust express
In mind her hidden loveliness,
And from her cool silence stream
The cricket's cry and Dante's dream:
For the earth that breeds the trees
Breeds cities too, and symphonies,
Equally her beauty flows
Into a savior, or a rose—
Looks down in dream, and from above
Smiles at herself in Jesus' love.
Christ's love and Homer's art
Are but the workings of her heart;
Through Leonardo's hand she seeks
Herself, and through Beethoven speaks
In holy thunderings around
The awful message of the ground.

The serene and humble mould
Does in herself all selves enfold—
Kingdoms, destinies, and creeds,
Great dreams and dauntless deeds,
Science that metes the firmament,
The high, inflexible intent
Of one for many sacrificed—
Plato's brain, the heart of Christ:
All love, all legend, and all lore
Are in the dust forevermore.

Even as the growing grass
Up from the soil religions pass,
And the field that bears the rye
Bears parables and prophecy.
Out of the earth the poem grows
Like the lily, or the rose:
And all man is, or yet may be,
Is but herself in agony
Toiling up the steep ascent
Toward the complete accomplishment
When all dust shall be, the whole
Universe, one conscious soul.

Yea, the quiet and cool sod
Bears in her breast the dream of God.
If you would know what earth is, scan
The intricate, proud heart of man,
Which is the earth articulate,
And learn how holy and how great,
How limitless and how profound
Is the nature of the ground—
How without terror or demur
We may entrust ourselves to her
When we are wearied out, and lay
Our faces in the common clay.

For she is pity, she is love,
All wisdom she, all thoughts that move
About her everlasting breast
Until she gathers them to rest:
All tenderness of all the ages,

Seraphic secrets of the sages,
All prayer, all anguish, and all tears
Are but the dust, that from her dream
Awakes, and knows herself supreme—
All but earth when she reveals
All that her secret heart conceals
Down in the dark and silent loam,
Which is ourselves asleep, at home.
Yea, and this my poem, too,
Is part of her as dust and dew
Wherein herself she doth declare
Through my lips, and say her prayer.

JOHN HALL WHEELOCK.[1]

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[1] From *Dust and Light* (Yale Review Press), Charles Scribner's Sons, 1919.

CHAPTER II

THE ORGANIZATION OF LIFE

Each in His Own Tongue

A fire-mist and a planet,
A crystal and a cell,
A jellyfish and a saurian,
And caves where the cavemen dwell;
Then a sense of law and beauty
And a face turned from the clod—
Some call it Evolution,
And others call it God.

A haze on the far horizon,
The infinite, tender sky,
The ripe, rich tints of the cornfields,
And the wild geese sailing high;
And all over upland and lowland,
The charm of the goldenrod—
Some of us call it Autumn,
And others call it God.

Like tides on a crescent sea-beach,
When the moon is new and thin
Into our hearts high yearnings
Come welling and surging in:
Come from the mystic ocean
Whose rim no foot has trod—
Some of us call it Longing,
And others call it God.

A picket frozen on duty,
A mother starved for her brood,
Socrates drinking the hemlock,
And Jesus on the rood;
The millions who, humble and nameless,
The straight, hard pathway plod—
Some call it Consecration,
And others call it God.

William Herbert Carruth.

The Will-to-larger-life.—We have taken a swift glance at the amazing drama of an inert fragment of the cosmic universe becoming alive. Were the elements in this mass possibly ejected with violence from some distant solar body and already endowed with the essential plan or pattern of a gigantic cosmic whole? We can almost believe that this is true as we witness the purposeful march of the atoms of our world-dust, struggling relentlessly, not only to live and to remain alive, but to achieve a larger life.

We have seen the "Spirit move upon the face of the waters," and the "deep quicken." We have seen inert atoms arrange themselves in flexible, sensitive, and adaptable organized groups, and under the stimulus of mysterious force from the sun-star that seems to have given birth to our earth-life we have seen that life reach toward its parent sun with such intensity of purpose we are told that, unhindered, it would now fill the solar universe.

The *will-to-live* is the most tremendous force which has yet appeared upon our earth, but we find in all living organisms an even more significant compulsion, and that is a *will-to-larger-life*, which scientists call *evolution*. The result of the will-to-live has been survival of species. The result of the will-to-larger-life has been the evolution of new and complex forms of living things apparently directed toward some distant cosmic end, perhaps immortality itself.

Many millions of years stretch between that first quivering life in the ancient receding sea and our child.[1] We are told, however, that there has been no break between that ultramicroscopic bit of protoplasm and him.[2] Truly the will-to-larger-life has carried him a long way on the road to immortality.[3] Verily that speck of life has seen adventure before it came to lie within the nourishing womb of the mother of our child. It is small wonder that the spirit of adventure still lives within the heart of every child. It is distilled into his very cells! His body knows how it struggled for long eons within primeval slime; how it rolled about the shore in spineless discontent; how it swam within the sea. He kept his feet upon the ground when some of his primitive brethren took to the air. Now he is fairly launched in conquest of land and sea and air. Ever his spark of life lived on with larger-will-to-live and cast defiant challenge at the outworn shells of forms it left behind. Can we doubt that in this flesh, or some future form of it "he shall see God"?

[1] Some scientists believe that collogenesis, or creation of life, is going on all the time and has been taking place wherever favorable conditions exist. This seems reasonable, but does not alter the fact that evolution of the present human race has doubtless required the full range of time since the first creation of earth-life.

[2] Some one has said rather facetiously, "We all were present at creation although we knew it not."

[3] Every true scientist believes that the known is but a fragment of a cosmic unknown plan of which our finite minds can only vaguely think. Every true scientist also believes that every creed and every faith has had its place; each gives way to a larger faith as we "need a bigger God to manage a bigger universe." Fasten says (*Origin through Evolution*, p. 25), "There is no reason why the disclosures of evolution should not be incorporated into religion. The scientist desires a reasonable faith, and is convinced that the facts of evolution not only are compatible with religion, but materially strengthen it."

The details of this fascinating story may be found in many readable and popular books on evolution as well as in all standard texts on zoology, biology, and in more specific technical writings.

The Tree of Life.—The will-to-larger-life leads to endless diversification in life forms, which is due, presumably, to the endless diversity implicit in the hereditary proteins and the chemical compositions of living organisms. This diversification of life is usually represented as a branching tree. Even a genealogical family tree becomes very complex; what shall we say of a biological family tree! It may simplify the concept, however, if we sketch this diagrammatically, showing only the major forms which life has assumed up to the present time.

It will be seen that man is not believed to have been once a monkey or an ape (to mention an older popular mis-conception of evolution); rather, both man and monkeys derived from a common vertebrate stem, hence the similarities which puzzled anthropologists for so long. *All living forms have ascended a common path* up to the time of their evolutionary departure from the main trunk to form new branches or forms of life. This departure from the common path is doubtless caused, or determined, by mutations in germinal structure interacting with environmental conditions, as discussed in the next chapter.[1]

The Evidences of Evolution.—The rock strata of the earth are full of fossil records of the progress of our child, as indicated in the diagram (Fig. 3), from protozoon to gastrulate to vertebrate, from primitive vertebrate to early mammal to man. The most indubitable evidence, however, has been preserved by Nature within the delicate and indestructible tissues of the egg. Every germ cell is an egg, every egg is a germ cell. The egg of our child began as a microscopic bit of protoplasm pinched off, so to speak, from the parent structure but containing the entire pattern of the ancestral parent structure compressed within its tiny space. It is as primitive, for aught the microscope reveals, as the first one-celled protozoon in the ancient sea. In the mother's body it rapidly becomes a gastrula (a very simple spherical animal form); acquires gill slits and fins; exchanges these for four legs and a tail and becomes covered with soft fur

[1] PLUNKETT, C. R., *Outlines of Modern Biology*, chap. XXIV, Variation and Selection, Henry Holt & Company, 1930

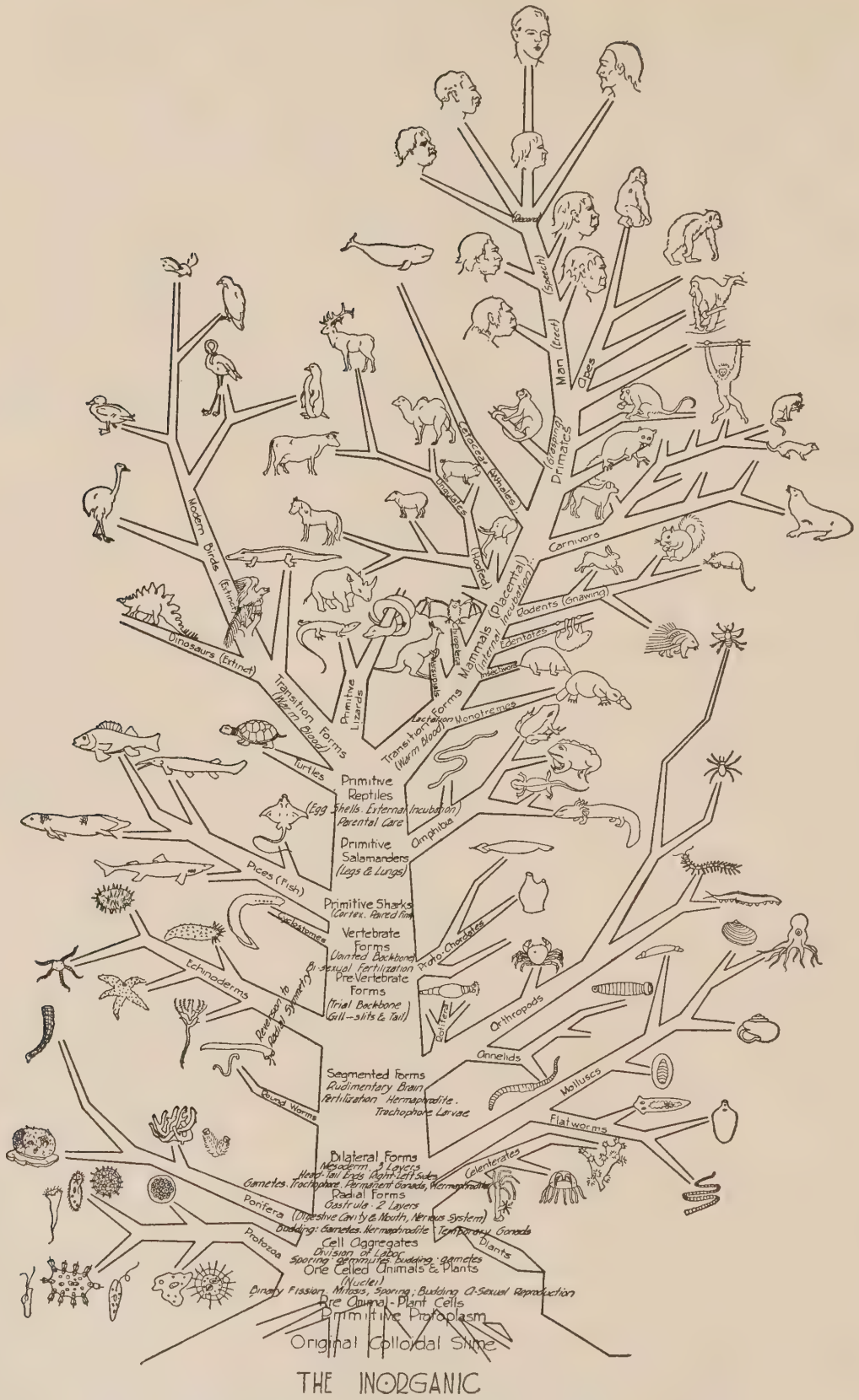


FIG. 3.—The tree of animal evolution. (*Maud A. Brown.*)

(lanugo). When our human child is born he is still the most unfinished, helpless living thing upon the earth. He has lost his fur and tail, but it takes him still 12 months to come to use two

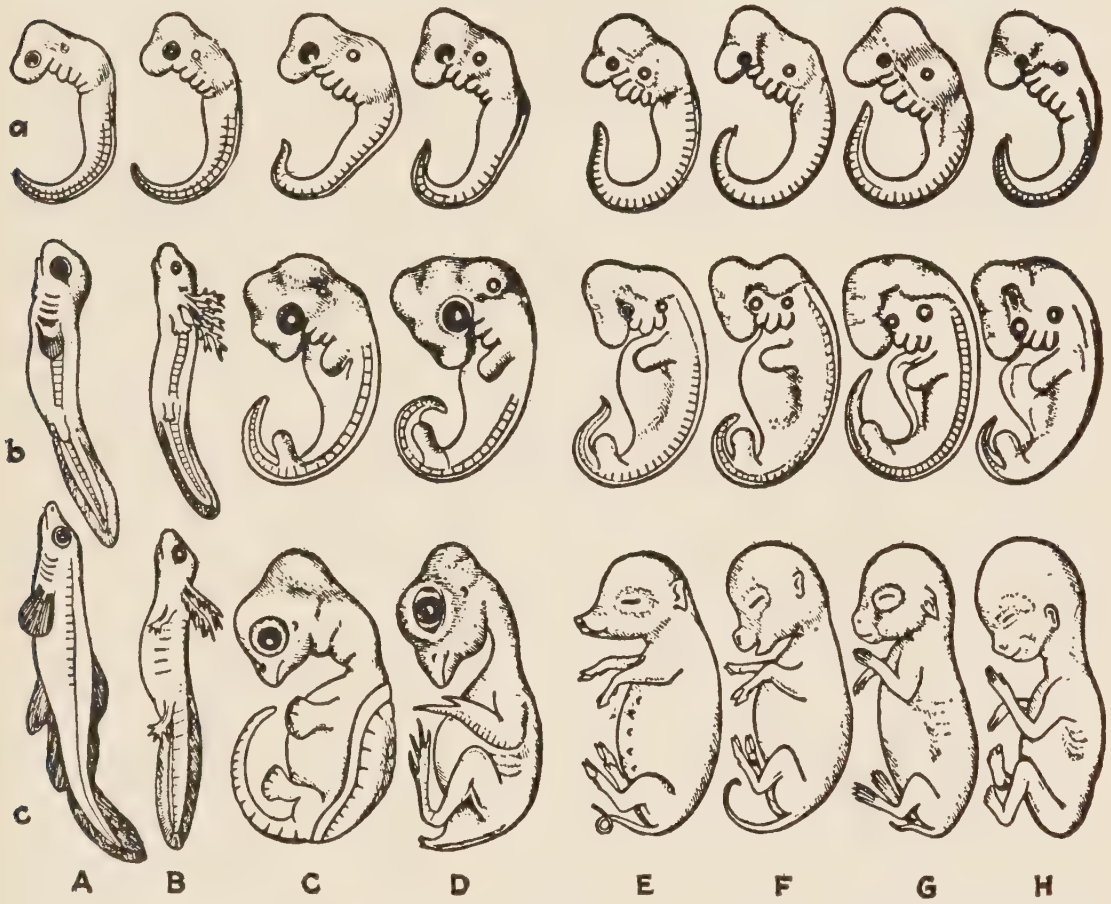


FIG. 4.—Parallel stages in the development of several vertebrates. *A*, fish; *B*, salamander; *C*, turtle; *D*, chick; *E*, pig; *F*, calf; *G*, rabbit; *H*, man. In each series, *a* is an early stage, showing the pharyngeal slits; *b*, a later stage, in which the first two have developed gills and the last six show the pharyngeal slits disappearing and the limbs and tails development; *c*, a still later stage, in which the differences between the reptile and bird on the one hand and the mammals on the other have become pronounced, marked resemblances between those of each group persisting. (*From Guyer, "Animal Biology." after Haeckel, through Romanes.*)

legs instead of four, and many years to catch up with his race. In short, he climbed his tree from protozoon to gastrulate, to simple vertebrate, to mammal, to primate in 9 short months. In a real sense he must still become a man![1]

[1] "It seems just to conclude that as the human child before birth recapitulates, more or less, certain phases of his physical history, so the child after birth recapitulates and uses for a time various phases of his prehuman ancestral behavior."—ALEŠ HRDLIČKA, *Children Who Run on All Fours*, McGraw-Hill Book Company, Inc., 1931.

This tendency of all living forms to rehearse certain stages of their ancestral history is expressed in the *theory of recapitulation.* Sometimes it is said that "ontogeny (the history of the individual) repeats phylogeny (the history of the race)." Sometimes it is said that "the child climbs his own racial and family tree." What this means is that there seems to be a necessary uniformity in living processes. Nature has evolved, so to speak, *one biophysical method of proceeding from simple to complex, a vital action pattern, which operates universally in all living organisms in both embryonic and postembryonic growth,* although affected within definite limits by differing environmental conditions.

The Dominance of Pattern or Plan.—Attention has been called to the fact that it is not the number and kinds of atoms and molecules which enter into the formation of an organism which are significant so much as the method of their arrangement; the pattern or plan of their organization gives individuality to the organism.

No matter where we turn our attention we are impressed with the idea that we live in an organized universe. Everything, animate and inanimate, seems to be imbued with an urge to associate itself with something else to form a larger whole, to become organized. Protons and electrons arrange themselves in atoms; atoms arrange themselves in crystals and in molecules; molecules combine with anything and everything which is chemically compatible in their environment to form the micellae which in turn become arranged in the orderly structures of colloids and protoplasms.

There is an almost endless variety in the patterns which may be achieved with one unit of structure. A pile of brick may be made into numberless patterned forms, a pavement, a wall, or a tower; two or three kinds of brick, or both brick and stone, can be made into many more patterned designs. With every additional variety of unit more patterns may be made. When we come to colloids, literally innumerable varieties of patterned organization become possible, and the result is the unnumbered millions of living forms which we see upon the earth.

The source of the pattern; the reason for the reckless, prodigal waste we see in Nature; why life must struggle endlessly for dominance, and the unfit perish—these are still baffling secrets of the Great Unknown.

The significance of the organization idea has recently motivated research on the part of certain scientists here and there: biologists, neurologists, psychologists, physicists, and chemists. Just now these investigators are finding each other and putting their results together in a very illuminating fashion. They are organizing their findings! They are creating an "organismic" philosophy, or school of thought. Without going deeply into the technicalities of the organismic theory, we shall use this theory somewhat in endeavoring to interpret the origin, growth, and development of the child.

The Mechanism of Organization.—While, as has been said, the *source* of the plan or pattern is still the great mystery, many interesting and illuminating observations are being made as to the *manner* in which the pattern of an organism appears and unfolds. Let us think for the moment of the egg from which our child is to proceed. Here is a microscopic mass of protoplasm which holds within its already highly organized colloidal structure certain specific proteins which it received from the germinal structures of its two parents. It is these which seem to have the selective power to choose what shall be taken from the environment to make up, not only the organism we call a child, but the specific qualities which make *Our Child.* It is these which hold or constitute the pattern.

Since all isolated, flexible masses are forced by the equalization of pressure of surrounding air or water to assume spherical shape, we find the fertilized egg to be a sphere. Each such sphere displays a surface-interior pattern. The surface becomes the environment of the center of the cell. The relationship of the various parts to each other varies. Some points become chemically more active than others. The protein particles in particular become active or initiate chemical activity. These points of heightened activity were studied by C. M. Child and given the name *gradients,*[1] since the activity of this center of chemical change has a focal spot of intensity in its center and gradually merges, or grades into the matrix or background tissue. The term *physiological gradients* has become commonly and technically used in this country to indicate any focal area of varying chemical

[1] Child, C. M., *Physiological Foundations of Behavior*, Henry Holt & Company, 1924.

activity in living tissue. Gradients of activity occur in the development of the embryo, in all growth, and also in living

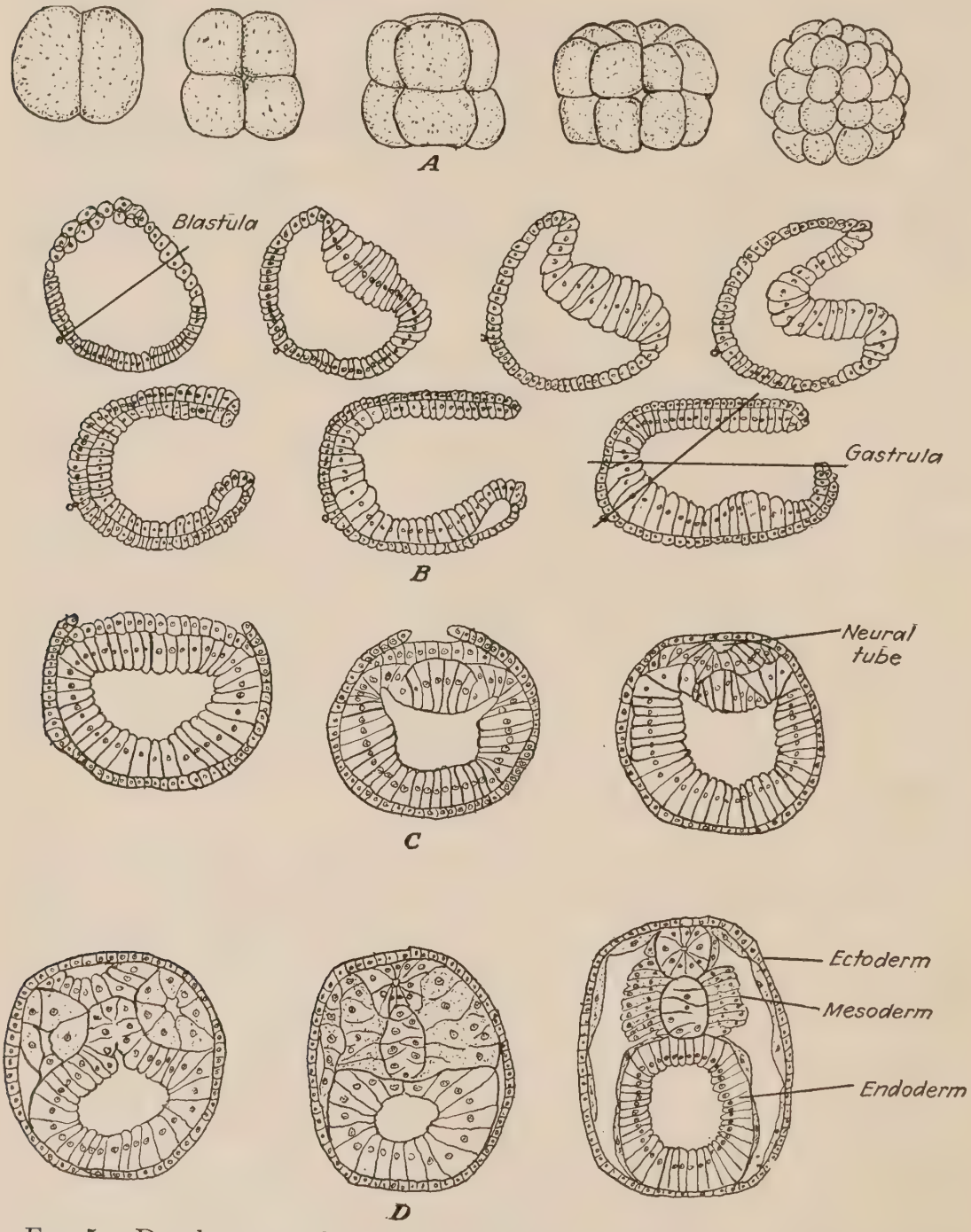


FIG. 5.—Development of embryonic layers: *A*, early cleavage of the fertilized ovum; *B*, gastrulation in Amphioxus; *C*, formation of the neural tube in Amphioxus; *D*, differentiation of ectoderm, endoderm, and mesoderm in Amphioxus. (*Modified from Wieman, An Introduction to Embryology, McGraw-Hill Book Company, Inc.*)

activity and function such as digesting, feeling, and thinking. Dr. A. C. Douglas of Edinburgh has recently described this

phenomenon of growth and activity with particular reference to nervous structures and mental activity, and he calls this process *sensitization* (in the sense of increased sensitivity), and applies to the spot or focus of sensitization the new word *senglion* (plural *senglia*).[1] Gradients or senglia may arise within the structure of the cell itself or within groups of cells as they operate within a tissue, and may represent structural change, or growth, or functional activity alone.

When this one-celled egg has absorbed and adsorbed nutrient fluid solutions (see page 17, chap. I), and enlarged to the limit

Structures Developing from the Germinal Layers

From the ectoderm:	From the mesoderm:
The skin	The connective tissues of the body
The hair	The bones
The lens of the eye	The teeth, except the enamel
The nervous system	All the muscles
The membrane of the mouth	All the blood-vessels of the circulation
The enamel of teeth	All the vessels which carry lymph
The membrane of the nose	The membrane lining the heart, lungs, and bowels
The lower part of the bowel	The kidneys and their ducts
From the endoderm:	The reproductive organs
The lining of the alimentary tract	The blood itself
The lining of the larynx	The fat and the marrow
The lining of the trachea and lungs	
The cells of the liver, the pancreas, the thyroid and thymus	

of its surface tension, it divides by *fission* into two exactly similar halves. Division proceeds until there is a spherical mass of cells, all alike so far as microscopic observation yet reveals. Here again a surface-interior variation is established between the various internal and external cells, and presently we see these cells differentiating or taking on differing structures and functions. In every multiple-celled organism the general sequence of differentiation is the same: first an external layer forms, called the *ectoderm*, then an internal layer known as the *endoderm*, while soon a third mass develops between these two, which is the *mesoderm* (Fig. 5). A list is given above of the particular structures which develop from these three layers. In simpler forms of life these structures are simple and few, while in man they are

[1] Douglas, A. C., *The Physical Mechanism of the Human Mind*, p. 101, E. & S. Livingston, 1932.

very complex. The interesting thing to us is to observe Nature's orderly and uniform method of working through endless adaptation and variation of basic or fundamental processes.

While these layers are forming, the sphere itself is flattening (for reasons which will receive attention later) and the ectoderm is already showing active gradients which indicate where the brain and spinal cord will be (Fig. 6). The surface-interior pattern is becoming *axiate*, that is, lengthened in a manner that is

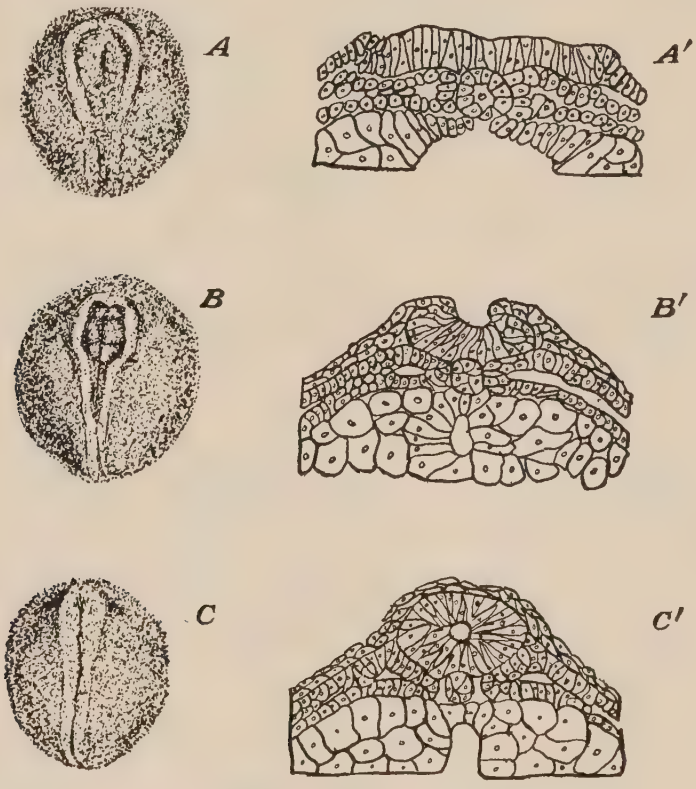


Fig. 6.—Formation of the neural groove in the egg of the Amphibian. *A*, the early neural plate of the egg; *A′*, cross section of *A*; *B*, the late neural plate, or neural groove, of Cryptobranchus; *B′*, cross section of *B*; *C*, closure of the neural tube; *C′*, cross section of *C*. (*Modified from Herrick, Neurological Foundations of Behavior, Henry Holt & Company.*)

to produce head, body, and feet; presently the axiate pattern will show *anteroposterior* variations which will cause our child to have a front and a back to his body, and also *lateral* variations which will account for arms, hands, ears, etc.

While the chemist and physicist have been bringing order into our thinking about the ultimate structure and organization of the materials of the universe, the biologist has been watching gradients of activity "emerge" from apparently homogeneous masses of primordial or embryonic cells and proceed with astound-

ing accuracy, concentration, and intensity to become nerves, bones, hands, or complex organs like the eye or heart.

The appearance of these gradients, or spots of sensitization, with their apparently purposeful behavior, is not the only, or even the most, amazing feature of this story. The thing we would, perhaps, most like to know is what it is which spaces and integrates the appearance of the various gradients so that the result *is* a dog, bird, or child, every part and organ developed and perfected in due order and proportion. The gradients are timed to each other as if an invisible bandmaster waved a baton for each to tune into a symphony of growth.

Gradients and Heredity.—One of the important recent contributions to the subject of growth is that of Dr. George Coghill of the Wistar Institute of Experimental Biology of Philadelphia. Dr. Coghill has, over a period of years, been making a study of the development of the nervous system in the amphibian Amblystoma (which is a very convenient animal for experimental purposes) and has been making very exact correlations between structure and behavior. Dr. Coghill found that *the essential, fixed, or hereditary structures develop in anticipation of function and in a fixed evolutionary order.* For example, sight centers in the brain are ready before the optic nerve enters the brain, and before the rods and cones can be recognized in the retina. The swimming mechanism is ready before it is used, etc. He says that there is all along the way "an overgrowth of neural mechanisms beyond the capacity of the animal to express their full nervous potential in behavior";[1] and that in respect to physical behavior this overgrowth may have specific reference to particular future behavior such as walking or swimming.

Coghill says that behavior is not simply a combination or coordination of reflexes but that there is from the first a dominant organic unity which concerns itself first with the maintenance of the integrity of the individual, and only after the "total individuation" do local reflexes or partial patterns emerge which may be affected by outside experience.

He says further that after the fixed or integrating mechanism is laid down and function begins, the further development,

[1] COGHILL, GEORGE, *Anatomy and the Problem of Behavior*, p. 92, The Macmillan Company, 1929.

growth, or differentiation is constantly affected by experience, but that this always takes place as a "quality upon the ground" of the organism itself. Experience is experienced, so to speak, by the total mechanism on a basis of its central plan. He further says: "The behavior pattern is a unity from first to last in the career of the individual. . . . Although the behavior at any moment may be dominated by some particular phase of experience, it cannot be utterly disconnected from any part of the whole."[1]

We shall see the reason for spending so much time and space in consideration of the meaning of this organismal concept and of its associated mechanisms as we make practical application of this to the physical and mental development of the child. It is becoming apparent that we must try to identify the order of appearance of the features of the pattern in the growing child and to be able to identify those that are primary, dominant, or hereditary in the organic matrix, and those that are secondary or modifiable by training or environment, and to recognize the emergence of these in physical and mental behavior. This is the basis of understanding and effectiveness in our care and training of the child.

Summary.—Life seems to be a purposeful force which is endowed not only with a capacity for self-perpetuation, but with a further powerful drive to accomplish some distant end. This drive toward an end, or will-to-larger-life involves an increasing complexity of organization which we call evolution. The highest product of evolution at the present time is man. The ultimate purpose can be only vaguely guessed, but it is conceivable that earth-life may eventually overcome all the obstacles which now inevitably thwart and destroy it, and thereby become actually and literally immortal.

While the cosmic plan is a matter of conjecture, many details of its realization are now known. These seem to reveal, increasingly, a unity of method running through all the phenomena of animate and inanimate creation. In the living world all life begins as a simple cell. The first life was only a single cell. As evolutionary changes appear all new forms of life travel the

[1] *Ibid.*, pp. 106–107.

same general path up to the place at which the new form starts on a career of its own, or branches off from the tree of life.

Every fertilized seed or egg has wrapped up within its microscopic nucleus (the protein parts of it, to be exact) the pattern or plan for the individual which is to be produced from this germinal unit. In the presence of warmth and the moisture (water) necessary for the carrying on of its chemical activities this cell begins to select from its environment the substances necessary for the development of the particular pattern within its nucleus. Certain spots or areas become chemically more active than others; differentiation of the various structures is brought about through these locally increased intensities of chemical activity, to which have been given the name of *physiological gradients.*

The differentiation of structures goes on in a very fixed and uniform manner until the particular organ or part is ready to function. Its further development is affected to a considerable extent by its experience, activity, or environment. The legs of the child are fully formed before he walks. If he never actually "experiences" walking, however, the further development of structure and skill will be to a great extent arrested.

In other words, the egg seems to be automatically able to create the basic or hereditary structures of the organism and make them ready for use or function, and Nature has evolved a very fixed and orderly method of doing this, a method which she uses throughout the evolutionary ascent of living things. After the parts are made ready for function or activity *they must be used,* or the further realization of the inherent or potential plan of the organism may never appear.

Gradients of growth appear in obedience to the central integrated plan of the organism. Growth is a unified procedure, a process of chemical accelerations and retardations arising out of the homogeneous embryonic matrix of the organism, first in obedience to internal stimuli, later, in great and ever increasing degree, in obedience to the stimuli provided by environment and activity.

The order of growth and development of the individual roughly follows the order of evolutionary progress. Thus, upon a fixed and stabilized biological structure which is as old as life itself,

are grafted the endless variations which give us a changing world.

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CHAPTER III

HEREDITY

Chromosomes

Older than hate are we, older than time,
Older than God when God was newly spewed
Out of the mind of man; older than slime
Out of which man crawled dripping, heavy thewed,

With wet hair matted. Older are we—and young:
Young as a squirming babe in a midwife's hands
Or asleep in a womb: Young as words just flung
Out of mouth; or wispy new spun strands

Of a spider's web; or crimson butterflies
With wings still damp through breaking painfully
From tightly wound cocoons; as young as lies
Untold; and as the next tide of the sea;

Younger than grapes just purple; younger than
Tomorrow. Grayly old and young are we.
Guiding the stumbling groping course of man,
We are eternal, and eternity.

THOMAS W. DUNCAN.[1]

We have reviewed in general what is known about the origin and continuity and nature of life and the evolution of life from simple to complex forms. Our understanding of these subjects and of the child will not be so comprehensive as we would wish without some consideration of what science has to tell us about the heredity of the child and the intricate mechanism by which Nature contrives to accomplish the truly amazing results which we have sketched.

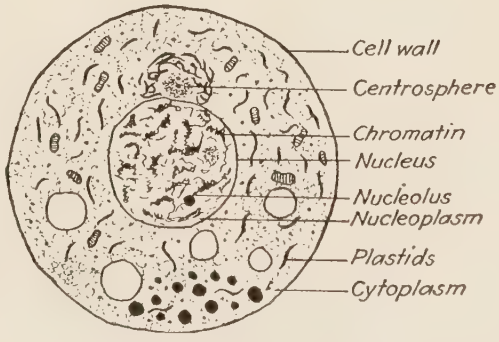


FIG. 7.—Diagram of cell structures mentioned in this text.

The Mechanism of Heredity. *The Cell.*—We shall start with the concept of the cell as the unit of organization of life. Every

[1] *Poetry* (Chicago), April, 1929.

egg and every seed-germ is a cell. Every living organism is a cell or a combination of cells together with the products of cell activity.

Every cell is a physico-chemical unit composed of protoplasm. Actually a cell is simply the largest mass of protoplasm which can carry on the intricate chemical changes described in the previous chapters. It is a metabolism unit. The most important constituents of protoplasm are, as we have seen, its specific proteins, fuels, and enzymes. The typical cell, whether it is a germ cell or a tissue cell, or a complete organism in itself, has a definite structure consisting of a mass of protoplasm called *cytoplasm*, which may itself have a very complex structure. Within this cytoplasm will be found a smaller, denser mass of protoplasm called *nucleoplasm* and known as the *nucleus*. Although there is no structural wall between these two parts of the cell, the surface tension, electrical and chemical reaction, and density are sufficiently different to prevent any intermingling of substances between the nucleoplasm and cytoplasm except under certain conditions which will be mentioned. Most cells have also one or more smaller bodies within the nucleus, each called the *nucleolus*, the function of which is still unknown.

Cytoplasm.—The functions of cytoplasm in the germ cell are not entirely understood. It is thought by some to have some hereditary function in that it may convey the larger group pattern, *i.e.*, body form, as having head, trunk, arms, legs, etc., and that the nucleus conveys the smaller unit characters, *i.e.*, the *kind* of skin, hair, eyes, etc., the body will have.[1] The cytoplasm is also known to contain enzymes, catalysts, and hormones, and it is thought that these may play a rôle in activating the protein within the nucleus at the time of cell division and reproduction. It seems certain that the nucleus must draw upon the cytoplasm for the materials for nutrition renewal and multiplication of its chromosomes and genes.[2] The surface of cell cytoplasm differs from the internal protoplasmic substance, and regulates, through its semipermeable membrane, the exchange of chemical solutions with the blood stream.

[1] Wilson, E. B., *The Cell in Development and Heredity*, pp. 1106–1112, The Macmillan Company, 1925.

[2] Howell, W. H., *Physiology*, chap. LIV, Heredity, W. B. Saunders Company, 1931.

Jennings says there is very intimate interrelation between the cytoplasm and the nucleus. "The cytoplasm is the material out of which the parts of the diversified body are manufactured, through interaction with the genes. But in development the cytoplasm is not passive; it reacts upon the genes, and what the genes do, what they produce, is largely determined by the nature of the cytoplasm in which, at different stages of development, they find themselves."[1]

Chambers, on the other hand, thinks the property of initiation resides in the nucleus. "There is experimental evidence that

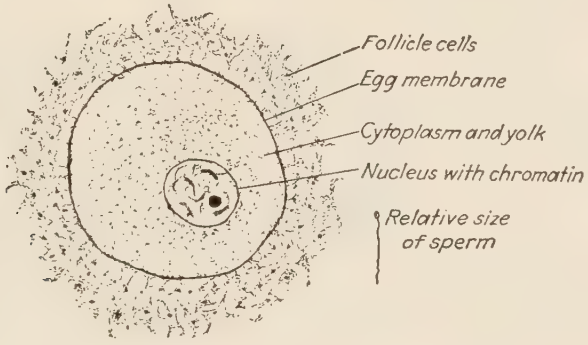


FIG. 8.—Male and female germ cells showing relative size; also follicular cells adhering to the ovum.

it (the nucleus) initiates peculiar changes in the cytoplasm and in the plasma-membrane within its vicinity. It remains for further experimentation to demonstrate the significance of what may prove to be the most vital feature of protoplasm, namely, the true relation of the nucleus to its cytoplasm."[2]

The male germ cell contains very little cytoplasm. It consists of almost naked nucleus (Fig. 8), therefore the cytoplasm of the fertilized cell comes almost entirely from the female cell.

One of the peculiarities of protoplasm is that it is found only in microscopic units known as cells which have the property of maintaining their unique structure in the midst of surrounding tissues or substances of a foreign character. Dr. Robert Chambers has invented instruments so delicate that he is able to dissect tissue cells under the microscope. He says the cell

[1] JENNINGS, H. S., *The Biological Basis of Human Nature*, p. 78, W. W. Norton & Company, Inc., 1930.

[2] NASH, JAY B., editor, *Mind-body Relationships*, chap. VII, p. 98, by Robert Chambers, A. S. Barnes & Co., 1931.

wall or surface is highly impermeable; also that it repairs itself under injury with incredible rapidity.[1]

The Nucleus.—The part of the cell which plays the major rôle in heredity, however, is the nucleus. The nucleus consists chiefly of a deeply staining[2] substance, *chromatin*, usually arranged at times of special activity in a definite number of masses called *chromosomes*. The chromosomes in turn are assumed to consist of an infinite number of highly complex protein units arranged in chain-like series and known as *genes*. The chromatin floats

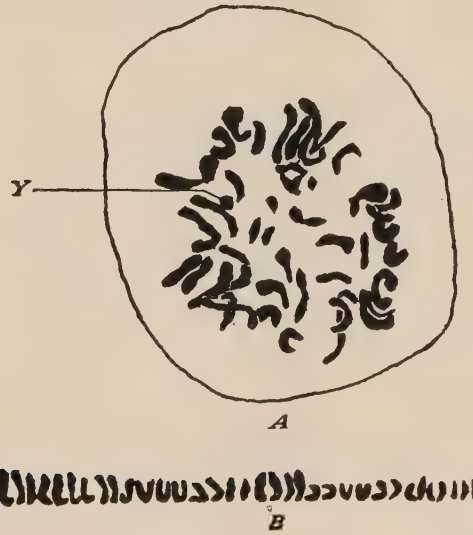


FIG. 9.—*A*, the 48 chromosomes in a cell of a white man; *B*, chromosomes arranged by pairs in order of size. (*After Painter, Eugenics, Genetics and the Family, Williams & Wilkins Co.*)

in, or is surrounded by the protoplasmic nuclear matrix, the *nucleoplasm*.

Chromosomes.—When a cell is about to divide or reproduce itself, either in growth, repair, or in producing a new organism, the chromatin, as already stated, becomes arranged in a definite number of masses or bodies called chromosomes (Fig. 9). There is always the same number of chromosomes in every body cell and every germ cell of individual plants or animals of the same species. Some insects and plants always have 4, others 6, and so on. Human body cells and germ cells appear to contain 48 chromosomes each. The chromosomes are irregular in shape and size, but the shapes and sizes are constant for a species.

[1] *Ibid.*, p. 98.

[2] Tissues are stained with various dyes in order to make the structure stand out more clearly under the microscope. Chromatin absorbs certain dyes readily and appears darker than the surrounding protoplasm.

Moreover, they are paired, apparently one of each pair having been contributed by the male parent, the other by the female. The existence of such a mechanism was predicted before it became possible to see it with any existing microscope. Now chromosomes are not only seen and photographed but can be watched upon the moving picture screen as they perform their "stunts."

Genes.—The chromosomes consist chiefly of an enormous number of infinitesimal protein units to which the name gene has been given. For a long time this was a working theory only, as no microscope had yet been invented which would make it



A *B*

FIG. 10.—*A*, Chromomeres in the chromosomes of the lily. (*After Belling.*) *B* shows a portion of *A* at a higher magnification. The chromomeres probably show the position of the genes. *From Jennings, The Biological Basis of Human Nature, W. W. Norton & Company, Inc.*)

possible to see anything as small as these. For that matter no one has ever seen an atom, still less an electron. "Genes" seemed mathematically to account for living phenomena and heredity in much the same way that the theories of atoms and electrons account for physical phenomena in chemistry and physics. Recently it has become possible to see the shadowy forms of chain-like shapes within the chromatin which Jennings calls *chromomeres*, and which answer the description of the hypothetical genes (Fig. 10).

Wilson says:

The nucleus possesses a definite architecture of which the most fundamental feature is the presence of a vast number of self-perpetuating and independent elementary units which correspond severally to genes or unit-factors of heredity. The evidence indicates that it is only these

units that pass on unchanged from generation to generation. . . . How genes or chromosomes operate is unknown; but we may suspect that they, like plastids and other cytoplasmic bodies, are centers of specific chemical action, and possibly may serve for the production of soluble enzymes or hormones. Without speculating on this question we here again emphasize the conception that the cell is a reaction-system and that the whole cell-system may be concerned in the production of every hereditary trait. In practice all the purposes of experimental analysis are sufficiently met if the hereditary "units," "genes," or "pangens" be thought of merely as modifiers which call forth responses, this way or that, according to their specific nature. To speak of them as "determiners" is to make use of a convenient figure of speech; but this need imply no more than that they are differentials by the use of which we are enabled accurately to analyze the observed results.[1]

Although Professor Wilson evidently did not have the then new theory of gradients in mind, his discussion of the rôle of the genes suggests that they may act as *determiners of gradients* or centers of heightened activity when they are transferred to a situation, such as fertilization and passage to the uterus, which activates or releases these potent unit-forces.

Jennings says:

A chromosome is proved to be a compound structure, consisting of many diverse and separable parts, each affecting the development of the organism, and therefore its characteristics, in a different way. It is convenient to have a name for these parts, and, as we know, they are commonly called genes. The word "gene" means nothing but these separable parts, having diverse effects on development, of which chromosomes have been proved to consist. In this sense therefore genes are demonstrable realities; not "hypothetical units" with mystic properties, as those unfamiliar with the evidence have imagined.[2]

Malcolm Little says:

It is now necessary to show that the gene is a chemical substance of the nature of a complex molecule, self-perpetuating and autocatalytic in nature. As yet this idea is in the hypothetical stage, for exact proof is lacking; but recent research is bringing it into the realm of a working theory.[3]

[1] Wilson, *op. cit.*, pp. 112–114.

[2] Jennings, *op. cit.*, p. 61.

[3] Nash, Jay B., editor, *Mind-body Relationships*, chap. VI, pp. 88–89, by Malcolm E. Little, A. S. Barnes & Co., 1931.

The Way the Hereditary Mechanism Operates.—An immense body of literature has grown up as the mathematics of the relations of electrons, atoms, and molecules has developed. A similarly extensive and impressive amount of technical literature is developing about the complicated and intricate relations of these literally innumerable, ultramicroscopic determiners of living destiny, the genes within their chromosomes, and their behavior within the organismic unit, the cell. Most of this is too intricate and too technical for the comprehension of the nonscientific person. However, it will help us to see the importance of the subject and its application to human affairs if we consider briefly the major outlines of present genetic theory.

When the human child (or any bisexual animal) is born he has present within his body in potential undeveloped embryonic form all the germ cells (with their power to create specific chromatin or germinal material) which he will ever have. Nothing which he can do can alter the potential quality of these germ cells other than through chemical injury. *Nothing which he can do can alter the inheritance his progeny will receive from past ancestors through him.* This was unalterably fixed at the instant of conception which determined the two germ cells, from among those present in the bodies of his parents, which were to unite at this particular time. At this moment he received his full contribution from the past and made his own to the future.

The combination of traits resulting from union and fusion of the male and female germ cells, then, becomes theoretically a matter of mathematical computation. Gregor Mendel, the famous Austrian monk, discovered that two traits mingled in heredity strictly according to the law of chance; *in the long run*, one-fourth of all germ cells being purebred like one parent, one-fourth being purebred like the other parent, and one-half being hybrid, but having the appearance of the dominant parent. Mendel knew nothing of chromosomes, still less of genes, but he saw clearly that there were double hereditary factors in every individual. He demonstrated that these traits separated in fertilization although he did not know by what mechanism they did this. He demonstrated that traits are sorted in the offspring by the law of chance and that "recessive" traits may be covered by the "dominant" traits in the hybrid, thus explaining why

certain black-eyed individuals breed true and others will have progeny of other eye colors. We know that all this is explained by the sorting and distribution of the genes and chromosomes. This is essentially as simple as shaking 100 beads, 50 of one color and 50 of another, in a box. The law of chance will, in the long run, bring each color to the surface an equal number of times.

The mathematics of the combination of two traits is simple: when four or six or a thousand different kinds of beads (traits) are shuffled, involving traits from remote ancestors, the mathematics becomes bewildering, but we can understand that the whole process is orderly, obedient to law—and mathematically valid.

We have seen that the unit-characters or genes lie in chains within the chromosomes and that there are corresponding pairs of chromosomes within each cell. This actually means two "determiners" or genes or genegroups for each unit-trait which appears in the individual.[1]

The chromosomal pattern (and presumably the gene pattern) is the same within the germ cell producing an individual, and within all the body cells in the same individual. Originally each cell was potentially an individual (we remember there were originally only one-celled organisms), but the body cells had to give up their individuality as they came under the control of the integrating force of organization and came to be surrounded closely by other cells, similar to or different from themselves, instead of being surrounded by air or fluid. The more complex the individual the less able is any one cell to reproduce the whole; it becomes specialized to such a point that it can only reproduce its own variety of tissue. In the frog, by girdling but not completely separating the egg when it is just beginning to divide and is in the two-celled stage, a two-headed individual is produced. If the two cells resulting from the first cleavage in a fertilized human germ cell happen to separate identical twins result. Normally, it is probable, one of these two first cells develops into the right, the other into the left side of the body. The earthworm, if cut in two—a process which removes the environmental restraint upon the cells adjacent to the injury and also stimulates the local gradients—proceeds to grow new

[1] JENNINGS, *op. cit.*, chap. I.

head and tail respectively upon the cut ends, producing two new and complete individuals, showing that the complete pattern is potential in each cell. It is well known that the injured crab can grow new feet or legs, the jellyfish new tentacles. In some vegetable species a whole new plant will grow from a small piece or even a leaf.

Mitosis.—Division of the cell is usually accompanied by complicated alteration in the chromatin structure called *mitosis* (thread-forming). This is the same for plant and for animal cells. The chromatin first assumes the appearance of a skein of thread, then the chromosomes form, but appear to be strung



FIG. 11.—Mitosis, or indirect cell division. (*After Kirkpatrick and Huettner, Ginn & Company.*)

upon skeins of threads along the line of cleavage (see Fig. 11). The line of separation appears in most instances to be determined by the two centrosomes or "attraction spheres" which promptly form by division of the original single centrosome. The chromosomes then split in such a way that the pairs of genes in each chromosome are shared 50-50 by the new chromosomes (Fig. 11). The surrounding cytoplasm separates, the chromosomes then become resolved again into diffuse chromatin masses, and two exactly similar new cells have replaced the old cell.

Maturation.—When a male and a female germ cell are about to unite in fertilization instead of divide in growth, a somewhat different procedure takes place, by which both chromosomes and genes are reduced in number. This procedure, called *maturation*, is necessary in order to prevent the doubling of the normal number of chromosomes, and takes place only in germ

cells. If two complete human germ cells were to unite, the result would be a huge cell with 96 chromosomes. Nature has met this complication in the following clever manner. The chromosomes form and pair off along the line of fission (cleavage of the cell into two) in such a way that one of each like pair goes to each new cell (after *conjugation* or *synapse* with each other),

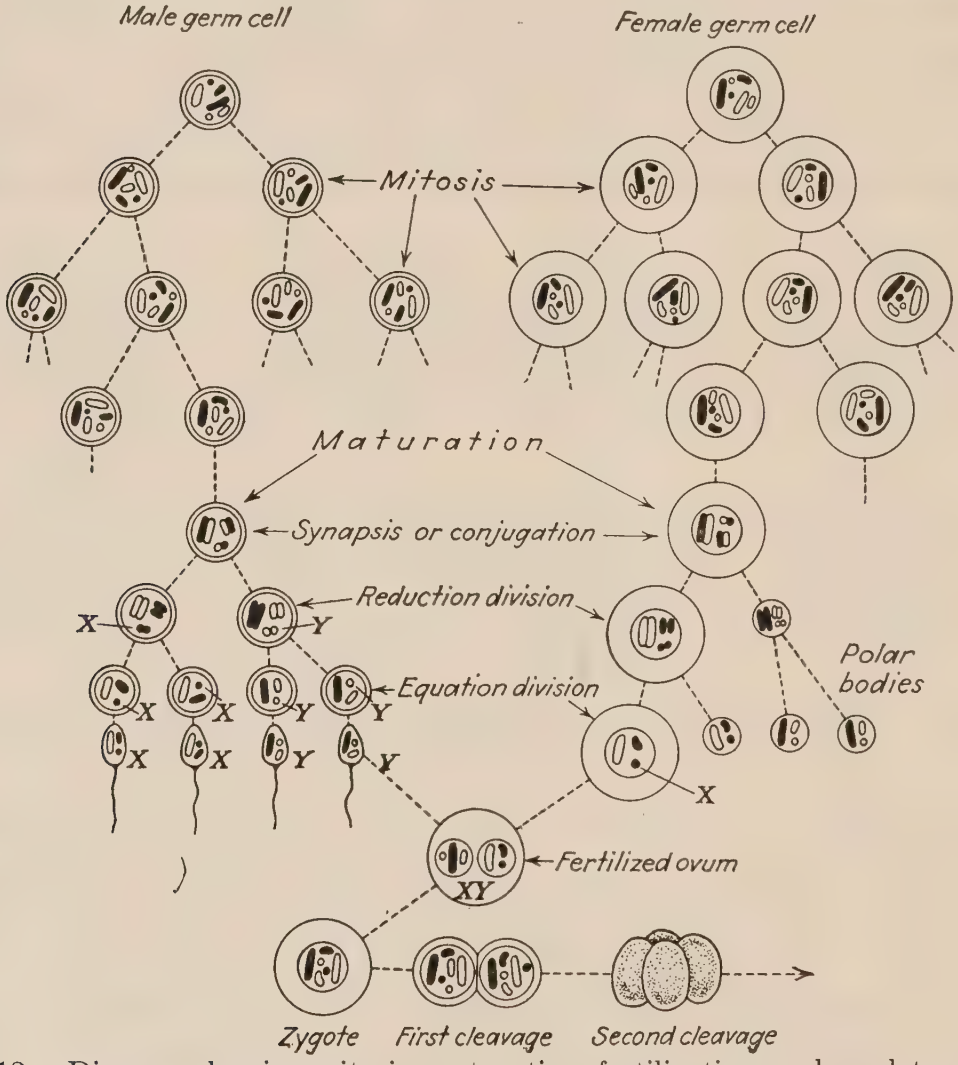


FIG. 12.—Diagram showing mitosis, maturation, fertilization, and sex determination in a species having six chromosomes.

reducing the number of chromosomes in the case of the human cell from 48 to 24. One of each pair is from the paternal and one from the maternal ancestor, and it is pure chance how these will be distributed in the new cells. This is called the *reduction division.* These 24 chromosomes then divide again, halving the chromatin material, *i.e.*, splitting the genes 50-50, but retaining the 24-chromosome pattern. This is called the *equation*

division. The final result is 4 cells, each containing half the original number of chromosomes (one of each kind or pair), each chromosome having one chain of genes. In mammalian reproduction, where the egg is incubated within the body of the mother and there is little loss, only 1 of the 4 cells from the original female germ cell is really finished. Three are lost as indicated in Fig. 12 as "polar bodies." There is still a tremendous waste in male fertilizing cells, so all 4 of these reduced cells are made ready for function in the form of sperm cells or spermatozoa.[1]

Linkage of the Genes.[2]—That heredity is not simple was seen as soon as the effort was made to apply Mendelian formulas to all hereditary phenomena. It soon became apparent that there is not simply one gene for every trait, but that a number of genes may be "linked" to produce one trait, and also that *one gene or group of genes may influence more than one trait;* also *various blocks of traits may be linked.* It is now believed that traits are con-

[1] The English author Aldous Huxley sees a dramatic situation in the perpetual and incredible waste of Nature:

A million million spermatozoa,
All of them alive:
Out of their cataclysm but one poor Noah
Dare hope to survive.

And among that billion minus one
Might have chance to be
Shakespeare, another Newton, a new Donne—
But the One was Me.

Shame to have ousted your betters thus,
Taking ark while the others remained outside!
Better for all of us, forward Homunculus,
If you'd quietly died!

ALDOUS HUXLEY, "Fifth Philosopher's Song," *Lea,*
Doubleday, Doran & Company.

[2] MORGAN, T. H., *The Theory of the Gene*, chap. I, Yale University Press, 1926; also NEWMAN, H. H., *Outlines of Zoology*, pp. 360, 366, The Macmillan Company, 1926; WEINSTEIN, E., *Chemistry in Medicine*, chap. II, pp. 50–62, Heredity and Development, The Chemical Foundation, Inc., 1928; JENNINGS, *op. cit.*, p. 69; and STOCKARD, CHARLES R., *The Physical Basis of Personality*, chap. IV, The Genes, Determiners of Personality, W. W. Norton & Company, Inc., 1931.

veyed in some instances by one gene, in which instance it becomes possible to apply the so-called Mendelian law. The dropping out or addition of one gene may modify a trait. It is said that a linkage of 40 genes determines the eye color of the fruit fly, 90 determine wing form, etc. The same block of genes which determines eye color may also share in determining other traits such as wing form, *and these traits will stay together in the hybrid cross* instead of separating as Mendel thought they would.

Crossing Over.—Bearing this general statement in mind we shall consider the maturation diagram with some additional details. As was mentioned, when the paired chromosomes lie side by side just before the reduction division they effect a sort of fusion or conjugation called the *synapse.* The cytoplasm and

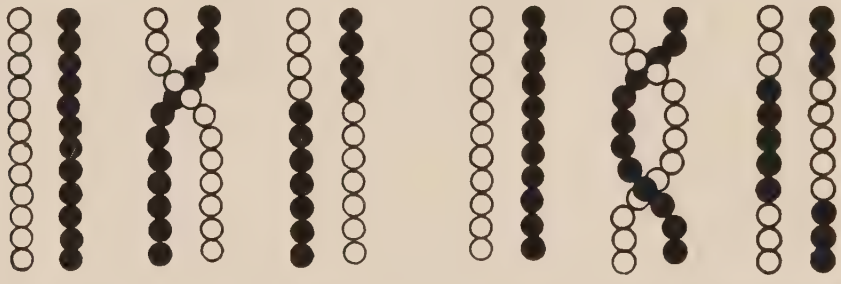


FIG. 13.—Single and double crossing over of genes during synapsis in maturation.

nucleoplasm mingle with each other, the paired male and female chromosomes may not only touch but may twist about each other, and at this time there may be more or less exchange between paired genes, both singly and in blocks. This is called *crossing over.* Sometimes the twisting is extreme and there may be double crossing over (see Fig. 13). This twisting and conjugation of the chromosomes, which are now readily observed, give opportunity for an exchange of genes, which would satisfy the mathematical requirements of the gene theory. The transfer of the genes has not actually been witnessed, but the evidence that this does occur is generally accepted by biologists.

The theory that life activity is chemical activity receives support from the fact that physico-chemical changes can be detected in the dividing cell during its heightened activity. The reaction of the chromosomes to stain is altered; the cytoplasm becomes more solid in the region of the centrosomes and more fluid in the plane of division, with increased surface tension in

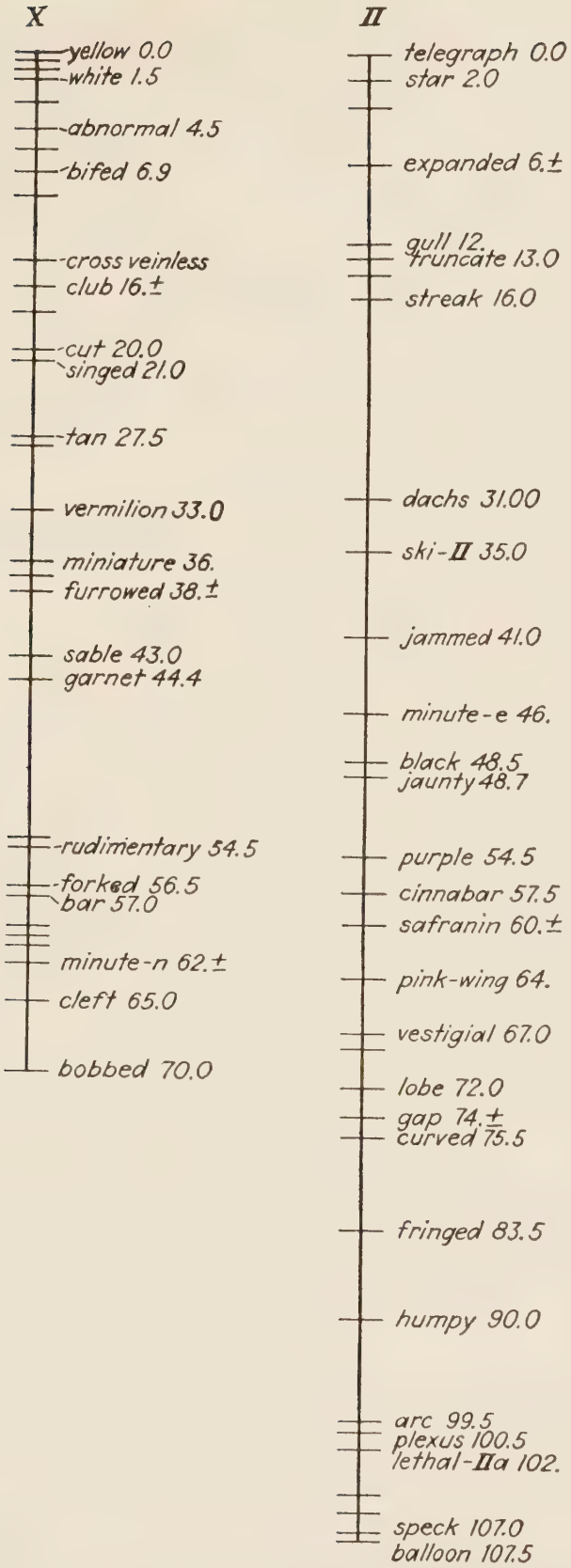


FIG. 14.—Map of the X-chromosome, and of chromosome II of Drosophila (fruit fly), showing the relative serial positions of the genes. Based on the maps given by Morgan, Bridges and Sturtevant. Names are here given for only a limited number of the genes that have been located. (*From Jennings, Biological Basis of Human Nature, W. W. Norton & Company, Inc.*)

the more fluid region. There is evidence also of differences in electric potential between chromosomes and cytoplasm.[1]

The chromosomes, after conjugation and the crossing over of the genes, resume their original form and are sorted into new cells, in each of which the nucleoplasm and cytoplasm separate and the typical cell structure again appears.

It is said that the linear arrangement of the genes is the same in any identical pair of chromosomes. The genes for eye color, for instance, will always lie side by side during the conjugation of the chromosome, and will always be found in a certain place within a certain chromosome.

This appears exceedingly complicated, but the mathematics of the procedure has been worked out in certain instances, notably with the fruit fly, until it has become possible to make chromosome maps, (Fig. 14) showing the particular traits which are contained in each chromosome, the number and character of genes belonging to each trait, and the particular order and sequence of the genes within each chromosome.[2] It is said that Professor Morgan has mated, crossed, and counted traits in many millions of fruit flies in his researches upon the behavior of the genes.

Genes in Heredity.—The provision of duplicate genes or traits from two parental lines complicates inheritance and also provides a certain protection. A defective gene in one chain may be covered up or protected by a normal gene in the mate to it in fertilization, especially if the normal gene be dominant. If corresponding genes are defective the defect will surely appear in the offspring (Fig. 15). Similarly, good traits may be intensified in the child if both parents provide genes for these. Thus children may be either brighter or duller in particular traits than either parent. This explains many of the observed apparent inconsistencies in inheritance and shows the difficulty in prediction of traits.[3]

The Sex Chromosomes.—In the diagrams of chromosomes for the human male germ cell (Fig. 9) shown on page 44 (also Fig. 12, page 50) it will be noted that all the chromosomes are paired, and that the two chromosomes of each pair are similar

[1] Weinstein, *op. cit.*, pp. 30–31.

[2] Newman, *op. cit.*, pp. 262–265; Morgan, *op. cit.*, pp. 22–23.

[3] Jennings, *op. cit.*, chap. I.

in size and shape, with the exception of two marked *X* and *Y*; these are the sex chromosomes which convey the inheritance or constitute the *germ plasm.* The others are the somatic or body chromosomes which will develop into the body of the new indi-



Diagram of a portion (six pairs) of the chains of genes in two parents, *P* and *M*, and in one of their offspring *F*, to illustrate the workings of heredity. The father (*P*) has two defective genes (white) in one of his pairs (the second) and is therefore personally defective. The mother (*M*) has both genes normal in this second pair. The child receives one of the sets of genes from the father (*p*), one from the mother (*m*). It therefore has in all its pairs at least one normal gene and so is not personally defective.

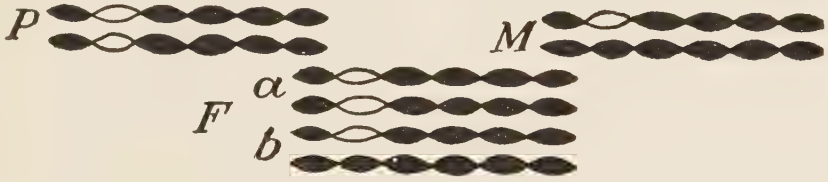


Diagram of the results in heredity in cases where one parent (*P*) has two defective genes (white) in a certain pair, the other parent (*M*) one defective gene in that pair. Some of the children (*F*) receive two defective genes in that pair (*a*) and are therefore personally defective; others only one (*b*), so that such are not personally defective.

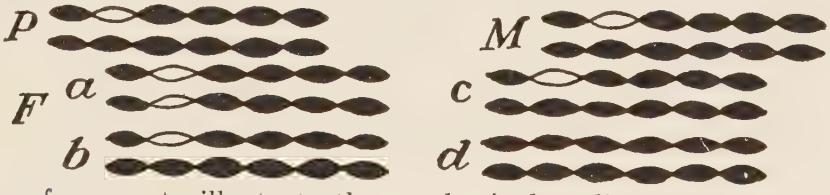


Diagram of genes, to illustrate the results in heredity when each parent has one defective gene (white) in the same pair. The parents, *P* and *M*, having a normal gene in each pair, are not defective. Of the children (*F*), some receive a defective gene from each parent, as at (*a*); such will be personally defective. Others receive but one defective gene (*b* and *c*), or none (*d*); these will not be defective.

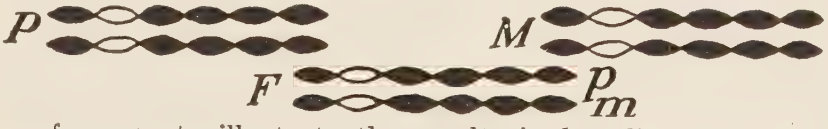


Diagram of genes, to illustrate the results in heredity when two defective parents, *P* and *M*, have both genes defective (white) in the same pair. The offspring *F* then receive one defective gene in that pair from each parent; such offspring are therefore personally defective, like the parents.

FIG. 15.—Diagram illustrating gene combination. (*From Jennings, Biological Foundations of Human Nature, W. W. Norton & Company, Inc.*)

vidual. The chromosome marked *Y* will be seen to be very small, so small indeed that it was not discovered for a long time, and all earlier works say that male cells contain one chromosome fewer than female cells. Also, the reduced mitotic cell was taken to be the representative cell form, and the earliest literature

on human chromosomes gave 24 female and 23 male as being the human chromosome unit. In the female germ cell, on the other hand, the two sex or *X* chromosomes are similar in size and shape.

Weinstein says:

> In man, as in most other species so far studied, the *Y* chromosome contains no genes that function in development, or very few as compared with the *X*. This alters somewhat the scheme of heredity. For while in the female each gene in the *X* has a corresponding gene in the other *X*, in the male each gene in the *X* is unpaired, since the *Y* is virtually empty. Hence the male contains fewer genes than the female and he does not transmit his genes equally to all his sperm; half of the sperm receive the empty *Y* chromosome and contain only 23 chromosomefuls of genes, whereas the *X*-bearing chromosomes receive 24. Consequently although the mother transmits her genes equally to her daughters and sons, the father transmits fewer genes to his sons. Therefore daughters inherit equally from both parents but sons inherit somewhat less from the father than from the mother.[1]

Genes in the *Y*-chromosomes are said to be *sex-linked.*[2] In the fruit fly there are some two hundred characters known to be carried in the extra *X*-chromosome of the female which are lacking in the male *Y*-chromosome. There are fewer sex-linked traits known in human inheritance. Color-blindness and hemophilia (a condition in which blood will not clot, producing "bleeders") are well known. These are recessive traits, and a female may receive the genes for the defect through the *X*-chromosome of her father. Even if she marries a man who is not color-blind, her male children are likely to be color-blind, since there is no normal gene in the *Y*-chromosome of their father to dominate the defective, recessive gene from the maternal grandfather, but the normal genes in the father's *X*-chromosome will protect his daughters although they may have color-blind sons. If the daughter of a color-blind father were to marry a color-blind man, the female children also might be color-blind. Since these conditions are rare in the population there is small chance of such a marriage; therefore such sex-linked traits occur chiefly in males.

[1] Weinstein, *op. cit.*, p. 54.

[2] Morgan, *op. cit.*, pp. 52 and 60.

The Determination of Sex.—Why one family has boys and another girls, and why the proportion of male to female remains so nearly constant in the general population, have always been great mysteries, and thousands of books have been written upon the subject attributing the determination of the sex of the child to famine, to war, to diet, to the time of the lunar cycle when conception occurs, etc.

The discovery of the sex chromosomes and the subsequent study of their behavior have cleared this matter, and it is now known that the simple, inexorable law of chance makes it probable that *in the long run* there will be as many XX combinations (females) as there will be XY combinations (males). This, however, makes entirely possible a grouping of XX combinations in one mating which will be offset elsewhere by a grouping of XY's in another mating (Fig. 12).

Variations.—We have considered the general subject of evolutionary change and also the mechanism of heredity which conveys traits from ancestors to progeny. It is obvious that the sorting of traits is accomplished at the time of maturation and fertilization of the germ cells, and that it would be biologically impossible for alterations to occur after this except through the agency of chemical or electrical injury, or other force brought to bear directly upon the germ cell. A study of embryonic development shows that Nature has made it difficult for anything to affect the fertilized germ cell.

The baffling subject of how evolutionary adaptations occur still remains obscure. The son of a blacksmith will have a right arm like that of any other child. Puppies are still born with tails although some breeds have been docked for hundreds of generations. Chinese girls are born with normal feet after centuries of foot binding. No one-legged father ever had a one-legged son. Shell shock, nervous breakdown, and technical skills are not inherited. Susceptibility to some types of feebleminded-ness, to epilepsy, to insanity, and to some other diseases is believed to be inherited. The present tendency in medical science is to regard only certain rather definite classes of defects as strictly inheritable, and to regard susceptibility to disease, rather than disease itself, as inheritable. Whether the susceptibility actually culminates in the disease depends upon conditions (environment).

At the same time, nothing is more certain than that adaptations and changes have occurred, steadily and consistently, since the appearance of life. While there are wide gaps in our knowledge as to how adaptations and variations occur, certain factors in the process are at least partially explained by recent genetic studies.

Mutations.—One reason for variation is that all through living forms *sports*, *mutations*, or *spontaneous variations* do now and then occur. There is no anticipating these. Science cannot, thus far, produce mutations except through injury to the germ plasm, and science cannot yet fully explain them. Nothing is more certain than that these also obey natural laws. In a mutation, quite unexpectedly, one individual will appear who is different in some particular trait from any which have preceded him. *Not only this, but he will transmit this trait to his progeny, showing that some change has occurred in the germ-plasm* (*sex chromosomes*). Many apparent variations are only accidental, such as monstrosities like Siamese twins, or double-headed calves (caused, doubtless, by the partial separation of the fertilized germ cell in its first division) and will not be inherited. Birth defects may be due to accidental changes in some of the 23 somatic (body) chromosomes and not to changes in the hereditary or sex chromosome.

Once in a while, as has been stated, a variation occurs which is due to, or causes, a permanent change in the reproductive chromosomes in the germ cell. This will be inherited as either a dominant or a recessive trait. Sometimes a hitherto dominant trait drops out, as in the case of the sport among calves which was born without horns on a Kansas farm and became the ancestor of all the hornless "Polled Herefords." The seedless orange originated in this way. Some variations or sports add something to the traits, as in the case of the navel orange. Every variety of apple originated as a sport, although subsequently greatly modified by artificial selection, "grafting," and breeding. The numerous varieties of wheat originated as sports and were selected and crossed to develop new combinations of characteristics for long roots, smooth beard, full head, or whatever it might be. Although more difficult to recognize, sports (mutations) must occur in human inheritance.

One reason mutations have seemed so mysterious is that only the spectacular ones were recognized. It is likely that the inheritance of small mutations over a long period of time has played an important rôle in evolution. Recent research as to the rôle the gene plays in living processes shows that linkage and crossing over of genes may produce an infinite variety of combinations of traits, and it is sometimes difficult to distinguish between these and true mutations. It seems certain that alterations in the character or arrangement of genes in the germ cells may occur and may become permanent and constitute mutations. It is also very probable that further advance in biological chemistry, particularly the chemistry of proteins and enzymes, will shed additional light upon the subject.

Müller says that mutations must inhere in the genes, and that all heritable variations and adaptations may be called mutations. He says that certain genes are vastly more mutable than others, and that the direction of mutation in a grouping or in a given gene may occur oftener in some directions than in others.[1] Mutation is also influenced by linkage involving more than one trait. In the fruit fly mutations involving one particular gene in a block of genes may produce a shortened wing, an eruption of the thorax, a lethal (death-producing) effect, or any combination of the three.

Most mutations are injurious to the organism, but occasionally a mutation arises which contributes to survival. It is now known that mutations may be produced by subjecting germ cells to high-frequency rays, such as *x*-ray and radium. Many more mutations occur in nature in regions where the radium emanations from the earth are stronger than usually prevail. Mutations may also be caused by subjecting eggs to extremes of temperature. Thus far no beneficial mutation has been artificially produced. Mutations in the germ cells may occur at any time during the life of the organism in which the particular germ cells lie. Mutations tend to be recessive rather than dominant.

C. B. Davenport, director of the Carnegie Institute of Experimental Evolution, declares that mutations are much more

[1] Müller, H. J., *Eugenics, Genetics, and the Family*, pp. 106–112, Mutations, Williams & Wilkins Co., 1923.

prevalent (if not universal) than is commonly recognized. Chromosomal unions are not always true to type; variations in chromosome numbers occur—sometimes the number is doubled or trebled, creating "polyploid forms" (having more than the normal number of chromosomes). Slips in arrangement of the chromosomes occur, and wholes or parts of unlike chromosomes may combine to form new types. He also discusses somatic or body mutation and declares that in definite and peculiar ways body changes can be inherited. An example occurs when a green branch appears upon a red-stemmed plant and it is found that *all seed borne upon that branch will produce green plants.* A patch of red grains sometimes appears upon an ear of purebred yellow corn, and will produce red corn. (This probably does not occur in animals and the cause of the phenomenon in plants is unknown.)

"Mutations may occur . . . from internal causes like the breaking down of the uranium, radium, lead series [which (see chap. I) are breaking down in Nature to form other elements]. From this point of view the cause of mutation is to be found in the nature or constitution of the genes themselves." This suggests that what really happens is some change in the chemistry of the specific proteins and enzymes mentioned earlier as constituting the basic substances of the genes.

Extremes of temperature apparently cause mutations, but Davenport says this merely retards or accelerates "the realization of potencies wrapped up in the genes. . . . Gene mutation can arise from the very mechanism of the gene."[1]

Natural Selection.—The other thing that determines the trend of change in inheritance and makes evolution possible is the law of *survival of the fit*, or *natural selection.* This law was worked out and given to the world by Charles Darwin, an English scientist who died in 1882.[2] Darwin became one of the most famous scientists of the world. He traveled much, and studied all that was then known about previous and contemporary forms of life. He made careful records of the types of life found in

[1] Davenport, C. B., Light Thrown by Genetics on Evolution and Development, *Scientific Monthly*, April, 1930.

[2] Darwin, Charles, *Origin of Species*, D. Appleton-Century Company, 1901.

isolated islands, and compared them with fossil life as found in the same islands. He formulated classifications and comparisons which were an enormous contribution for any one man to make to any subject. From all these, he concluded that in the continuous warfare that goes on in the myriad forms of life upon the earth it is the individual best equipped to take care of itself which survives and transmits this favorable dominance to its offspring, and in this measure changes or influences the trend of the general heredity of a species.

"One marsupial 'survives' because it is a jumper; another because it is a sprinter; another because it is a climber. One snake survives by turning a tooth into a hypodermic syringe, his saliva into venom; another keeps his teeth, but changes his skin to look like that of his poisonous brother; another parts with teeth entirely, and develops a spine in his gullet to break birds' eggs. He is 'adapted' for climbing."[1]

During an epidemic or plague, those individuals survive who have a great degree of natural immunity to the particular disease. When spawning salmon start upstream, only the stronger ones survive. Thus does Nature mercilessly *select for survival* through the pitiless *struggle for existence.* This is called natural selection, which results in the survival of the fit, and naturally should result in improvement of species and in increased survival in successive generations of a species.

Of course we are only saying that it is actually the environment which determines which mutations shall survive and be inherited, and which genes, among the enormous surplus provided by Nature, shall come to expression.[2]

M. F. Guyer reports "apparent" success in establishing the heredity of acquired opacity of the eye lens through nine generations of rabbits. He is careful to state that it is only apparently an instance of inheritance of an acquired characteristic and says very pertinently:

It is a commonplace of modern genetics that any characteristic of an organism requires not only an adequate stock of germinal materials,

[1] Dorsey, George A., *Why We Behave Like Human Beings*, pp. 98–99, Harper & Brothers, 1925.

[2] Plunkett, C. R., *Outlines of Modern Biology*, chap. XXIV, Variation and Selection, Henry Holt & Company, 1930.

which we call genes, but a suitable environment for its production. From this point of view, *an acquired character is one in which not the genic constitution but the environment has been changed.* The very fact that it can be called forth by a particular environment shows that the possibility of its expression already existed in the genes when a suitable evocative stimulus was forthcoming.[1]

"Survival of the fittest does not explain the arrival of the fittest"; so the surviving factor must be provided by spontaneous variation or mutation in the germ-plasm or genes which contribute something useful, or by the countless combinations made possible by mating of sexes. Or, as suggested by Guyer, in part by the prodigal provision in the billions of gene structures within the cells of the body for wide potentiality of selection and expression of traits.

Artificial Selection.—The deliberate suppression of undesirable or unwanted types, the crossing of desirable strains, and the selection, protection, and perpetuation of desirable mutations, constitute what is called artificial selection. Segregation and sterilization of the unfit, birth control, scientific agriculture, are all illustrations of artificial selection.

Eugenics.—*Eugenics may be said to be the application of the laws of heredity to human welfare, or the "self-direction of human evolution."*[2] It is actually a wide application of the principle of artificial selection. Sir Francis Galton, one of the foremost of the early genetic scientists, defined eugenics, a half-century ago, as "The study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally." He also said:

Man has the power of preventing many kinds of suffering. I conceive it to fall well within his province to replace natural selection by other processes that are more merciful and not less effective. This is precisely the aim of Eugenics. Its first object is to check the birth rate of the unfit instead of allowing them to come into being, though doomed in large numbers to perish prematurely. The second object is the

[1] Guyer, M. F., The Possibility of Modifying Germ Plasm, *Proceedings of Race Betterment Conference*, Race Betterment Foundation, 1928.

[2] Fasten, Nathan, *Origin through Evolution*, chap. XIV, The Future Evolution of Man, F. S. Crofts and Company, 1929.

improvement of the race by furthering the productivity of the fit, by early marriages and the healthful rearing of their children.

These two objectives are sometimes said to comprise *positive* and *negative* eugenics, respectively. It is difficult today to improve upon these statements of social objective. The realization of these ideals, however, seemed simpler and more immediately possible when less was known about heredity and the developmental processes.

We are familiar with the great contributions which such knowledge as we have of the laws of heredity has made to man's material welfare within a short quarter of a century. We are just beginning to apply this new knowledge to man's racial welfare. We have been forced to make some human weed-laws, and to try to eliminate some social thistles through segregation in institutions, legal sterilization, and some regulation of marriage. We have not been very wise or effective in this, because of lack of clear understanding of biological laws, and because of the difficulty of applying them to complex human characteristics. We are at present much more disposed to protect than to eliminate the unfit. The result is that the socially ineffective procreate prodigally under the protection of society, whereas they would speedily die out through natural selection if they had to protect themselves. Some think there is real danger of society being overwhelmed with prolific undesirables. On the other hand, somewhat rigid voluntary selection is going on among individuals of good human stock who are at present rather commonly failing to replace themselves in the population.[1]

It is encouraging that genetic scientists are finding many fewer dysgenic (racially or genetically injurious) traits than were formerly supposed to exist, but enough still remain apparently valid to justify active endeavor to improve human stock.

We should be studying our individual trait-inheritance and at least avoid doubling our weak traits by mating like with like and thus visiting a curse upon the unfortunate "third and fourth generations." This is the reason the marriage of cousins is prohibited in many states. The defectiveness which is so often observed to follow such unions is not a moral curse, but only an

[1] JENNINGS, *op. cit.*, pp. 351–357.

instance of the operation of the Mendelian law that "Where two similar dominants are mated, the offspring will resemble the parents, and will in turn transmit this dominance to all their offspring" (we would state it more modernly as the bringing together of defective genes of the same sort). Recessive traits almost forgotten in family inheritance may also be doubled, and crop out in new intensity. Of course there is no certainty that

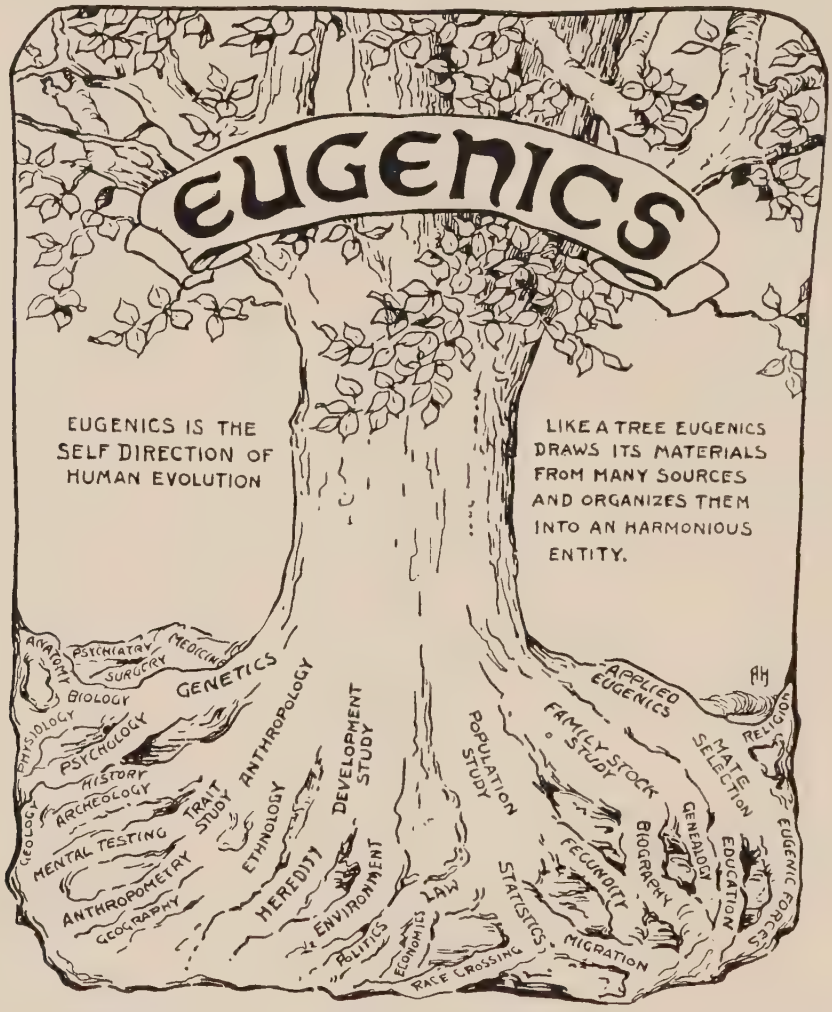


Fig. 16.—The eugenic tree. (*From the announcement of the Third International Eugenics Congress*, 1932.)

two cousins or even two brothers (unless identical twins) will happen to have the same dominance in their genes, but there is a greatly increased probability of this with cousins as compared with two unrelated persons.

Both strong and weak traits are intensified by inbreeding. This is shown where there is inbreeding because of geographical or political isolation as in China and Japan, or social isolation as in the instance of the so-called "lower classes" at one extreme

and royal families at the other. Even here the law of survival tends to weed out weaker traits.

Human Mating.—As to the individual application of these laws, it will be a long time before enough is known to make it possible to formulate very many safe and definite rules for the selection of mates. We do know enough to avoid mating with the defective, especially if their defects are of the same kind as those in our own ancestry, and to prevent as far as possible the propagation of the grossly unfit. Society should do this with increasing thoroughness and effectiveness through segregation, sterilization, and better and uniform regulation of marriage. No farmer will breed his stock to scrubs, but too often he sanctions the marriage of his children to members of a scrub family.

Family Records.—As to the conscious improvement of human heredity, little can be done until we begin to keep family-trait records. With the newer scientific knowledge at our service, we certainly should keep continuous and complete and detailed family histories, paying particular attention to character analysis and achievement records, as well as to chronological data.[1]

The very personal and important matter of improving the human animal through control of inheritance involves consideration of birth control, which may be either eugenic or dysgenic in its effect according to circumstances. It also involves legal regulations of marriage and legal sterilization and segregation of the unfit, control of immigration, and many other social and legal questions which cannot appropriately be discussed here, in spite of the fact that the solution and management of the problems indicated have a great deal to do in determining the kind of a world *Our Child* will come to live in. Certainly all thinking parents should try to see all issues in terms of the child of the race and his best interests.

Environment.—We are too prone to discuss heredity and environment as if they were separate aspects of the child's life which we should constantly try to keep apart. In a sense this

[1] Forms for doing this may be secured from the American Eugenic Record Office, Cold Spring Harbor, Long Island, New York, or from the American Eugenic Society, 185 Church Street, New Haven, Connecticut, or from the Race Betterment Foundation, Battle Creek, Michigan. A thoroughly scientific record for the first 16 years of life may be secured from the Parents' Magazine, 114 East 32d Street, New York City.

is true if we are to avoid the mistake of expecting the impossible of the child on the one hand, or of neglecting his proper culture on the other. It is both cruel and useless to try to make a musician out of a child who is lacking in sense of tone and rhythm. Most children, however, are capable of much greater musical appreciation and skill than are ever developed by their environment.

As a matter of fact, heredity and environment are so interlocking in character that it is impossible to separate them except in certain gross aspects. Professor Seba Eldridge expresses this truth in these words:

> Perhaps the most conspicuous property of living organisms is their community with the environment. Not only are living beings continuously dependent on the oxygen, water, and food substances which the environment supplies, but the chemical substances of which the body is composed are all derived from the environment.
>
> So intimate is this relationship that organisms might be, and often are, conceived to be just parts of the physico-chemical world which are organized in a certain way. This conception has, quite apart from its truth or falsity, emphasized the fact that the organism is bound up with the environment at every stage of its existence, if it does not indeed stand to the environment in the relation of a part to the whole. Between them there is a constant interaction which is never interrupted until the organism perishes and becomes an unorganized part of the physico-chemical world. . . . What is true of an organism as a whole is true of its component cells and tissues. They all have, at every moment of their existence, an environment without which they can neither exist nor be conceived. . . . These processes of interaction between the organism and environment, including the interactions between component parts of the organism and *their* environments, constitute what is termed functional, or physiological, activity.[1]

Child sums up the matter of environment vs. heredity thus.

> Of course the particular type of these mechanisms and their relation to any particular organism is primarily a matter of hereditary constitution and potentialities of the protoplasm constituting the organism, but in the development of the individual certain physiological conditions are necessary for the realization of these hereditary potentialities. These physiological conditions originate in the physiological gradients.

[1] Eldridge, Seba, *The Organization of Life*, pp. 1–2, Thomas Y. Crowell Company, 1925.

. . . The organism . . . is not . . . "the collective action of the genes" but rather the collective *reaction* of the genes to the differential action of the environment. We may say then that pattern and development, as well as the function of the individual organism, represent the behavior of the germ plasm in a given environment.

Or as he says elsewhere more briefly, "the organism may, in fact, be defined as *a pattern of relation to environment appearing in protoplasm.*"[1]

If this concept of unity which has here been sketched is true it follows that even mental and emotional qualities are inherited as potential expressions of protoplasmic function. What particular potential functions come to expression in behavior will depend, as has been said, largely upon environment.

In conclusion, let us not trouble too much with trying to differentiate between heredity and environment or between the physical and mental traits of the child. Let us rather try to think of him as above all a *unity*, "a behavior pattern in a specific protoplasm" (Child), or "a mechanism, but (he is) a mechanism which, within his limitations of life, sensitivity, and growth, is creating and operating himself" (Coghill).[2]

In short, the child is a growing organism. If he is a potato we cannot make of him a rose, but we can help him to grow into the very best possible potato if we foster the conditions appropriate to potato culture. We doom ourselves to disappointment, and the child who is potentially a potato and not a rose to suffering and failure, if we try to force him to climb a trellis and bear red bloom!

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[1] Child, C. M., *Physiological Foundations of Behavior*, p. 123, and also p. 10, Henry Holt & Company, 1924.

[2] Coghill, George, *Anatomy and the Problem of Behavior*, The Macmillan Company, 1929.

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CHAPTER IV

SOCIAL HEREDITY

Atoms as old as stars,
Mutation on mutation,
Millions and millions of cells
Dividing yet still the same,
From air and changing earth,
From ancient Eastern rivers,
From turquoise tropic seas,
Unto myself I came.

My spirit like my flesh
Sprang from a thousand sources,
From cave-man, hunter and shepherds,
From Karnak, Cyprus, Rome;
The living thoughts in me
Spring from dead men and women,
Forgotten time out of mind
And many as bubbles of foam.

Here for a moment's space
Into the light out of darkness,
I come and they come with me
Finding words with my breath.

SARA TEASDALE.[1]

Our child had a very insignificant physical start in life as a cell $\frac{1}{125}$ inch in diameter, and most of that cytoplasm. The nuclear or strictly hereditary part of him was very much smaller, quite microscopic in fact. Whitney says the sperm cells that fertilized the ova from which developed the nearly two billion people now living upon the whole round earth could be held within the cupped palms of one pair of hands.[2] Verily, as we have said, our child as he stands before us is literally composed of environment—except for that infinitesimal speck of specific protoplasms which held the unique pattern that makes of him an ensemble of environment differing from every other organism or individual which ever has lived or ever will exist (unless our child should be one of identical twins, and environment may modify the development of even these).

It is therefore apparent that the relationship of our child to his environment is at once a very intricate and a very important matter. This relationship of the 48 chromosomes from whence he came to his environment involves various aspects of heredity

[1] "The Voice," *New Voices*, The Macmillan Company.

[2] WHITNEY, LEON, *Basis of Breeding*, p. 21, Earle C. Fowler, 1929.

which we should bear in mind in our attempt to understand his development. We commonly think that he inherits only the unique complex of genes and chromosomes from which his physical body comes. But is this strictly true? His first environment is his mother's body, upon this he entirely and absolutely depends for nine months' growth, during which time he increases his initial size many million times. Does he not, in a very real sense, inherit his mother's body and the eons of evolutionary history which perfected it for his use? After birth he remains dependent upon his mother's body, including her mind and emotions (which we now believe to be functions of her body), for nourishment and care. His environment now includes not only the nutriment from which he builds his body, but *maternal solicitude*, a peculiar and specific attitude involving sacrifice of self-interest, without which he would speedily perish. Did he not inherit this? Does this not belong to him as basically and intrinsically as does his body pattern? Did these not come down the ages of evolution along with the pattern for his body mechanism?

Furthermore, our child inherited not only a mother but a father, in short he has inherited an evolutionary situation, the evolutionary status quo of the particular stream of life along which he came. This situation includes not only his particular genes and chromosomes with their potential gradients of growth, but also the fact that he has two surviving and fostering parents instead of a parental ameba which would have obligingly and sacrificially obliterated itself in twin progeny; the fact that these parents are Caucasian, blue-eyed, and hybrid for red hair; that their native tongue is English and their name Jones.

Nor is this all that has come to him individually and personally from the past. Scarcely less intrinsic in his environment (from which he has selected the "makings" of himself with such completeness and fidelity as he could), than are the facts that he is white, English, and a Jones, are the facts that his particular white, English Joneses and their forbears, out of their particular protoplasmic urges, formed families in patterned groups, also an organic social relationship called a state, a country. All of these he inherits, and all of these are as definitely functions of the composite protoplasmic pattern of his people as his own per-

sonality and physique are functional expressions of his own protoplasmic mechanism.

The survival of our child depends upon the fact that he has inherited the parental solicitude of ages of evolution; conversely and correspondingly he has inherited a long period of dependency and helplessness which increases, historically, as social evolution advances. As his state and country become more stable and autonomic and intricate he has become heir to a solicitude and a protection on the part of the group such that if his parental protection and care should fail, instead of perishing promptly and at once as would have been his lot in more primitive times, he receives foster care from the social group into which he is born. Is not this social attitude a matter of definite organic evolution converging in our child just as clearly as his body-mind and his long infancy are definite evolutionary products?

So we say with the poet (who is often intuitively a scientist as well as a prophet) that our child is literally heir to all the ages. We shall think of him as inheriting definite potentialities of body structure and personality, and also an equally definite physical and social environment which have entered into the structure and participated in the evolution of his body-mind potential and without which he could never have come to expression.

We shall think of him as being a unit or organism within himself and also as being a unit with other units which integrate and cooperate and limit and condition each other to form the social organism without which he could not live and without which his intelligence and spiritual capacities could not function any more than the hand can function when separated from the body. Jesse Feiring Williams says, apropos of inherited social behavior:

> All men, apart from training, possess tendencies to respond in certain typical ways to certain typical situations. These tendencies to respond are inherent in the nature of man. Without training this nature would appear to be a vastly different thing than most persons would imagine it to be. Thorndike, in writing of the need of education, says, "If all human beings save new-born infants vanished to another planet, and if by a miracle the babies were kept alive for a score of years, preserving whatever knowledge and skill came from natural inner growth, and lacking only the influence of the educational activities of other men, they would at the age of twenty-one be a horde of animals." It is

unquestionably true that any individual would be ashamed to be associated with the creature he himself would be by original nature alone. Man without the influence of training would show a truly barbaric type of conduct. The instincts of his original nature subjected to no modification would exhibit the cruelties, fears, and fightings of primitive man and, perhaps, even of the lower animals themselves.[1]

The concept of the dominance of pattern, and the theory that the relativity or relation of things is the only reality, and that man is simply one unit in a closely integrated and patterned cosmic order is gaining ground in general scientific thought.[2] One of the most logical expositions of the idea is found in the illuminating chapter on Biological Foundations of Social Integration in Child's *Physiological Foundations of Behavior*, from which we quote the following:

This conception of the organism as fundamentally a dynamic integration of behavior pattern in a specific protoplasm seems to throw light upon various fields of biology, which from other viewpoints have remained more or less obscure. Probably no one doubts that social integrations, patterns, institutions are fundamentally integrations of the behavior of living organisms in certain environments. Both the individual organism and human society represent behavior integrations of living systems.

The organism is a dynamic social order, pattern, or integration among living systems or units. A social organization is exactly the same thing. The fundamental difference between the organism and social integrations among human beings is apparently one of degree or order of magnitude. Social integration is a dynamic integration of human organisms, and the human organism is an integration of cells, tissues and organs. [Italics ours.] Unquestionably these differences in the order of magnitude of the integration determine differences in detail in the process concerned, but both cell and human being are living systems, and we believe that the human being is a product of evolution from the cell. We may expect therefore, to discover a fundamental similarity or identity in the more general laws and processes of integration from the one extreme of the cells or the simplest organism to the other of the great modern state or nation. The overlapping of biology and sociology and their use of each

[1] Williams, J. F., *Personal Hygiene Applied*, p. 47, W. B. Saunders Company, 1925.

[2] Shapley, Harlow, *Flights from Chaos*, McGraw-Hill Book Company, Inc., 1930.

other's terminology indicate that this is the case, but from the dynamic viewpoint this fundamental similarity appears even more clearly than from any other. . . . Certain significant and apparently fundamental similarities, or in a broad sense identities, in the processes and course of physiological and social integrations have been pointed out, and if these are admitted we seem to have some justification for regarding social integration as one aspect, plane, or order of magnitude of biological integration. . . . Both represent aspects of the behavior of living things.[1]

Jennings gives expression to a similar idea in *Biological Basis of Human Nature:*

The typical doctrine of emergent evolution holds that new properties and modes of action appear when the steps are made from atoms to molecules, from simple molecules to complex ones, from inorganic to organic. It holds that the properties of atoms do indeed depend on those that the electrons have *when they are in the atom;* the properties of molecules on those which the atoms have *when they are in the molecules.* It holds too that the properties of living things depend on those of their physico-chemical constituents *when the latter are in living things;* the activities of thinking beings on the action of their physiological constituents *when the latter are part of a thinking being;* the activities of societies on those of their unit individuals *when those individuals form part of society.* But it holds that the constituents of each grade acquire new properties, new modes of action, in becoming part of the emergent thing of higher complexity.[2]

Summary.—The purpose of this discussion has been to obtain a perspective of the child, of the forces which have made him, and of his setting and place and importance in the universe. We shall have need constantly to refer to these derivations, to follow back along our thread to get new starts, as we proceed in our endeavor to understand the unfolding gradients of human development in physical and mental growth and to see the practical importance and application of these to our subject.

Modern thinking postulates unity in all the phenomena of life, social as well as psychological and physiological; some think the unity extends to the inert or material universe as well. Some

[1] Child, C. M., *Physiological Foundations of Behavior*, chap. XVI, The Biological Foundations of Social Integration, and chap. XVII, p. 261, Henry Holt & Company, 1924.

[2] Jennings, H. S., *Biological Basis of Human Nature*, chap. XVI, p. 370, Evolution, W. W. Norton & Company, Inc., 1930.

scientists are saying that cell units such as nerve or muscle or gland obey social laws when they forfeit liberty and assume functions of service within the living body. When men associate in the social order they forfeit liberty and take on functions of service in the organization of community, state, and nation similar to the relationships of cells, tissues, and organs within the body, and may therefore be said to obey organic law.

Professor Child says that individuals are biological organisms which react to each other according to the same laws of physiological dominance, growth, and interaction as do the cell organisms in a living body. He says we are the products of a *social heredity* which has determined our character and appearance just as definitely as physical heredity has determined it. Social evolution follows the same laws as biological evolution and each conditions the other. Society is only the organization of larger biological human units which interact and integrate according to their mutual attractions and repulsions as determined by their inherited patterns and the effect of these upon each other.

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CHAPTER V

THE EVOLUTION OF REPRODUCTION

Afar down I see the huge first Nothing, I know I was even there,
I waited unseen and always, and slept through the lethargic mist. . . .
I am the acme of things accomplish'd, and I am encloser of things to be. . . .
Long I was hugg'd close—long and long.
Immense have been the preparations for me,
Faithful and friendly the arms that have help'd me.
Cycles ferried my cradle, rowing and rowing like cheerful boatman,
For room to me stars kept aside in their own rings,
They sent influences to look after what was to hold me.
Before I was born out of my mother, generations guided me,
My embryo has never been torpid, nothing could overlay it.
For it the nebula cohered to an orb,
The long slow strata piled to rest it on,
Vast vegetables gave it sustenance,
Monstrous sauroids transported it in their mouths and deposited it with care.
All forces have been steadily employ'd to complete and delight me,
Now on this spot I stand with my robust soul.

WALT WHITMAN.[1]

Perhaps the master secret of life itself is the mysterious force which inheres in all organic structure through which the "vital spark" is passed along through Time even unto (we hope and believe) Eternity. The highest present accomplishment of life upon our earth is the birth of a human child. That is what we are about to study. This supreme event will have somewhat more meaning for us if we consider briefly the long long sequences of experiments whereby Nature arrived at the delicate and intricate process through which we, as privileged end-products (as yet) of evolution, may share in the march toward immortality.

Fasten says:

During some period in the life of every organism, certain minute entities are set aside which are capable, under proper conditions, of reproducing all of the structures and functions of the adult parent from which they were derived. This power of reproduction has made possible the immortality of life since its origin upon the earth. In spite of the

[1] "Song of Myself" from *Leaves of Grass* reprinted by permission of Doubleday, Doran & Company, Inc., Publishers.

fact that individual organisms are constantly dying, nevertheless the most indestructible thing in all nature is life. Individually almost all organisms are mortal, but racially they are immortal. This immortality has been made possible by the unique power of reproduction which is possessed by every living thing.[1]

Forms of Reproduction. *Binary Fission.*—Any living cell multiplies itself by division of its nucleus, with its component chromosomes and genes, into two equivalent parts. It commonly does this through the process of mitosis (Fig. 11). In some very simple single-celled organisms mitosis may not occur or may occur in modified form. What seems to occur in all instances is that the one-celled organism on reaching the limit of its surface tension or cohesive power simply divides all its parts and structures in two exactly equal portions with or without mitosis. This is called binary fission (Fig. 17). Professor Lane thus describes the reproduction of ameba:

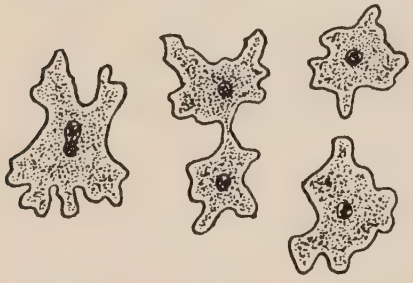


FIG. 17.—Reproduction by binary fission, or simple division, in the Ameba.

When through an abundance of food an ameba has reached its limit of growth, it divides into two like any other cell. Its nucleus goes through a modified form of mitotic division before the body divides. This constitutes its method of reproduction and is called "binary fission." Thus, ameba does not suffer a *natural death;* instead its substance passes directly into that of the two daughter-amebas. There is an awesomeness in the thought that no direct ancestor of an ameba living today has ever died; it is but the front of an advancing line of protoplasm which has gone on without a break since the first ameba appeared on earth.[2]

Sir Arthur E. Shipley waxes humorous in this wise over the sentimental plight of ameba.

When we were a soft amoeba, in ages past and gone,
Ere you were Queen of Sheba, or I King Solomon,
Alone and undivided, we lived a life of sloth,
Whatever you did, I did; one dinner served for both.
Anon came separation, by fission and divorce,
A lonely pseudopodium I wandered on my course.[3]

[1] FASTEN, NATHAN, *Origin through Evolution*, p. 68, F. S. Crofts and Company, 1929.

[2] LANE, H. H., *Animal Biology*, p. 50, P. Blakiston's Son & Co., 1929.

[3] SHIPLEY, SIR ARTHUR E., *Life*, p. 161, The Macmillan Company, 1925.

Reproduction by Budding.—By and by, in the course of evolution, certain one-celled organisms, of which baker's yeast is an example, began to bud off a number of young in succession without sacrificing themselves with each new birth. This is called reproduction by budding. Each organism is thus enabled to produce several or many offspring with increasing probability of survival of the species (Fig. 18, *A*). In these transitional phases of the evolution of reproduction more than one type of reproduction may be employed by one organism. Yeast sometimes reproduces by sporing or "internal budding" (see Fig. 18, *B*).

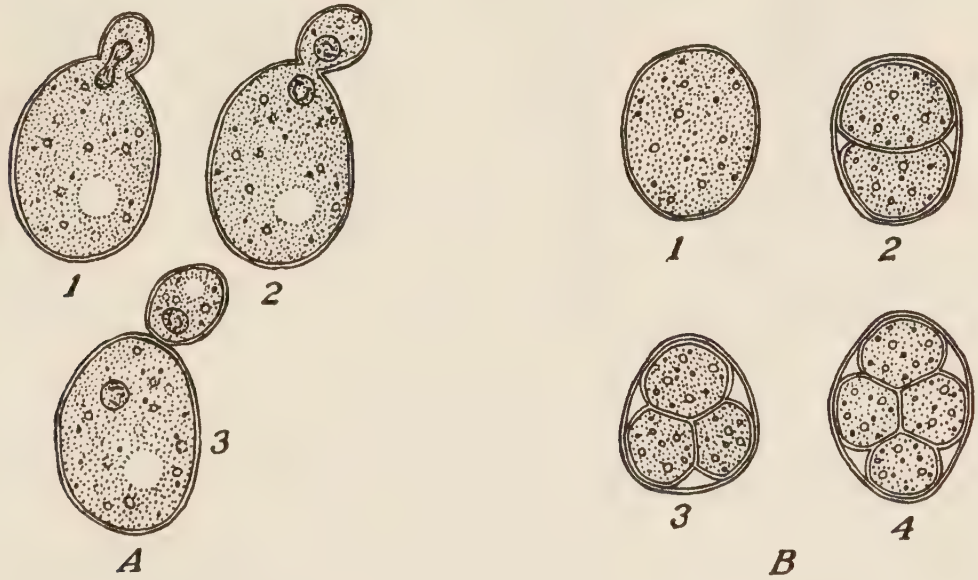


FIG. 18.—Two types of reproduction in yeast: *A*, by budding; *B*, by sporing. (*After Plunkett, Outlines of Modern Biology, Henry Holt & Company.*)

Hydra reproduces during part of the season by budding; during the rest it is a hermaphrodite (Fig. 22).

Reproduction by Sporing.—At a still later stage of evolution the cells budded off failed to separate; simple, multiple-celled organisms appeared, and the matter of reproduction became complicated. Nature has tried many devices, among which is the development of new cell nuclei or spores within certain cells. When ripe or at the climax of growth, these cells rupture and release many small spores into the water, where they develop into new individuals[1] (Fig. 19). Some organisms, when conditions of food, moisture, or temperature are unfavorable, form a number of divisions (spores) within the cell wall which may

[1] PLUNKETT, C. R., *Outlines of Modern Biology*, p. 366, Henry Holt & Company, 1930.

shrink or dry up and rupture. When warmth and moisture are again encountered each spore forms a new organism.[1] Some forms produce male and female spores or gametes which fuse with each other to form zygotes which develop into new individuals. Here again we may have two types of reproduction in one organism, as in ulothrix, a green alga (Fig. 19).

Conjugation.—The paramecium is a sexless, one-celled water animal which usually reproduces by fission. After many genera-

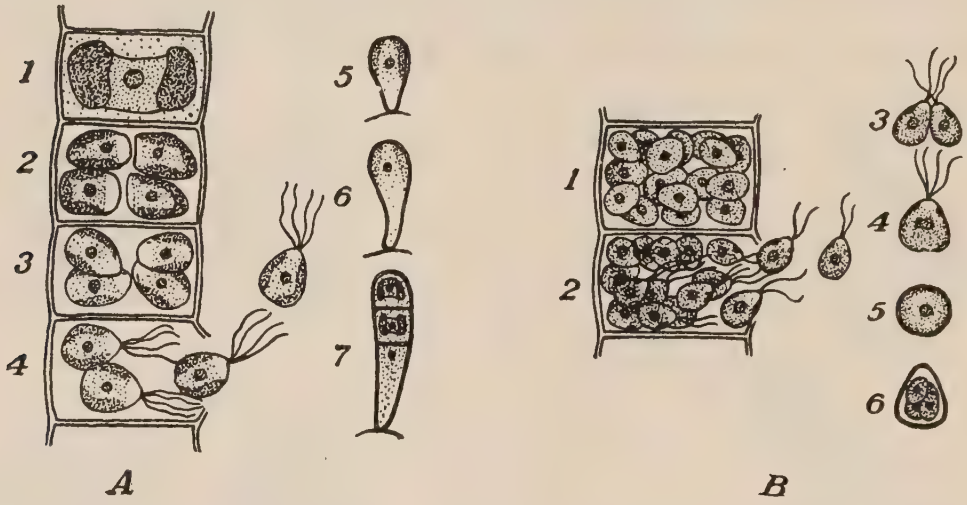


FIG. 19.—Two types of reproduction in Ulothrix: *A*, asexual sporing; *B*, sexual union of gametes to form a zygote. (*After Plunkett, Outlines of Modern Biology, Henry Holt & Company.*)

tions the cells lose vigor and seem about to die out. Then various pairs of paramecia fuse or conjugate; the nuclei unite, the cytoplasm and nucleoplasm mingle, and one large cell is formed. After a short time the cells divide again into two exactly similar individuals that seem, in certain instances at least, to have been mysteriously stimulated and rejuvenated by the experience and start out upon new careers of multiplication by division.

In spirogyra (pond scum), a simple stagnant-water plant consisting of a chain of cells, the union of cells from different filaments which happen to come into contact results in the concentration of the contents of both cells in one which then develops into a new plant (Fig. 20). Dorsey comments in this wise upon this peculiar phenomenon of rejuvenation: "Other protozoa only partly unite—and again separate, 'rejuvenated.' In other species, a small individual bores into and buries its body within that of a normal sized individual; the latter then divides repeat-

[1] SHIPLEY, *op. cit.*, pp. 161–164.

edly. Thus far there has been no division of labor or true sex forms. When two unite the conjugation is an energy stimulus, as

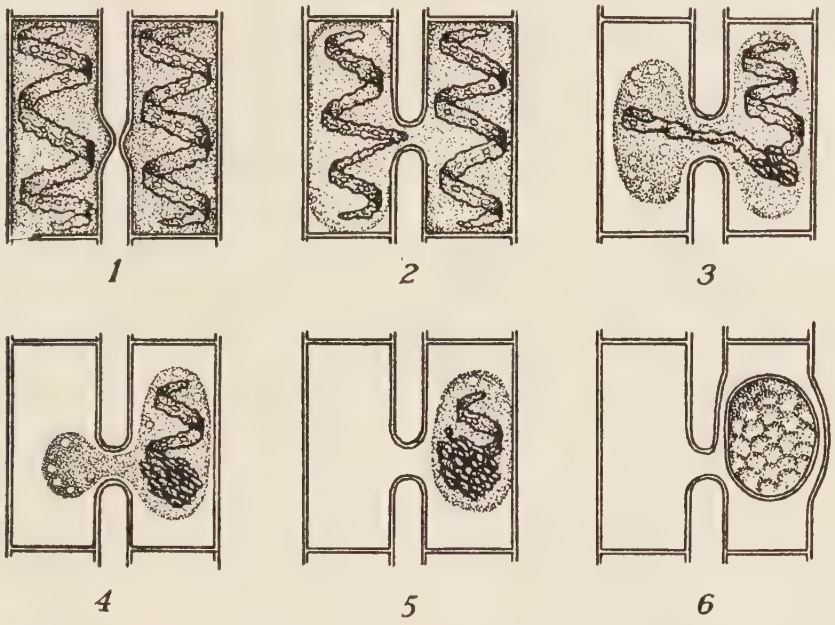


FIG. 20.—Conjugation and sporing in Spirogyra. (*After Plunkett, Outlines of Modern Biology, Henry Holt & Company.*)

though the springs of life needed rewinding. In higher organisms, this rewinding becomes the prime function of the sperm-cell."[1]

Sex Cells.—The foreshadowing of sexual reproduction seen in primitive types of conjugation between similar or sexless cells progresses a step further in volvox. This is a spherical colony of cells, each of which has long cilia or flagella which propel it through the water. This fringed, hollow ball floats about in stagnant water absorbing food until it reaches maturity, whereupon certain cells enlarge and become filled with egg-like bodies. Other cells become filled with smaller, slender sperm-like bodies. Both kinds of cells rupture, discharging their contents into the fluid in the interior of the sphere. Now the sperm-like bodies, aided by their flagella, hasten to fuse with the larger egg-like cells, and from each such pair a new volvox

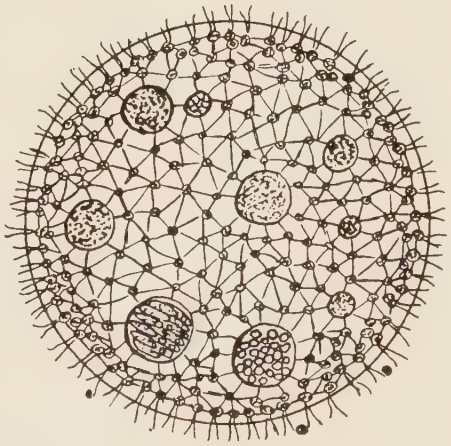


FIG. 21.—Reproduction in Volvox.

[1] DORSEY, G. E., *Why We Behave Like Human Beings*, p. 105, Harper & Brothers, 1925.

develops (Fig. 21). This is clearly a foreshadowing of sexual reproduction, although both kinds of sex cells are produced in one parent colony (in some species the ova are produced in one individual colony, the sperms in another).

It is interesting to note that the parent structure soon disintegrates and dies, no matter how favorable conditions may be. This is the first real appearance of natural death, and seems to be the necessary price for evolutionary advancement. The many-celled individual is not immortal in time or space in the same sense as the one-celled organism which passes on in its entirety into its progeny. Only certain, highly specialized portions of the complex organism, known as germ cells, are budded off and retain this gift of perpetuating life.

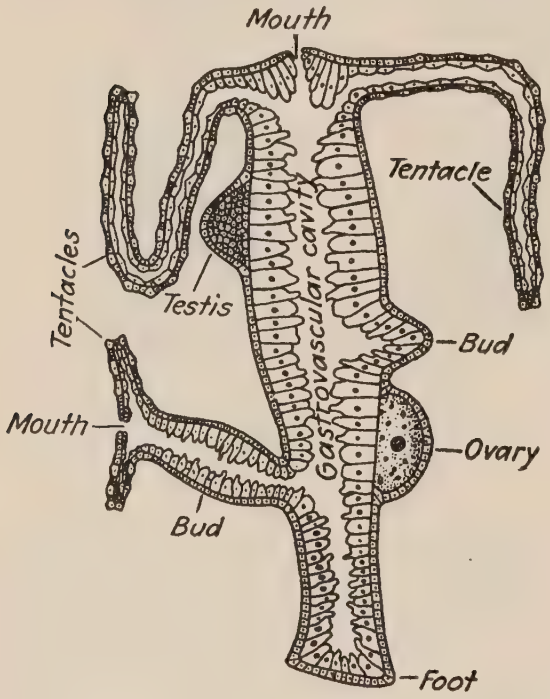


FIG. 22.—Two methods of reproduction in Hydra: budding and hermaphroditic (primitive sex organs). (*Modified from Shull, Principles of Animal Biology, McGraw-Hill Book Company, Inc.*)

Hermaphrodites.—In later and more complex forms of life special male and female sex organs develop within the body of one animal, each producing successive crops of sex cells of opposite kinds. These unite and produce new individuals having both male and female sex organs within the body of each. A very primitive type of hermaphrodite is the Hydra (Fig. 22). Many plants reproduce in this way. Individuals having both kinds of sex organs are called *hermaphrodites.*[1] In very rare instances both kinds of sex organs are produced in bisexual animals. This is an unnatural reversion and the organs are never sufficiently complete to function.

Sexual Reproduction.—Later, very much later in the story of evolution, separate male and female individuals appear, and

[1] SHIPLEY, *op. cit.*, p. 185; also NEWMAN, H. H., *Outlines of General Zoology*, pp. 191–193, The Macmillan Company, 1926; and PLUNKETT, *op. cit.*, pp. 380–381.

possible variations in inheritance are thereby incredibly multiplied. Earlier forms of sexed organisms have few traits and simple structure, and many of the laws of inheritance have been worked out on these and have later been found to apply to all forms of life.

In truth, the male sex seems to have been created or "invented" for the purpose of increasing variations as well as for stimulation of the ovum.[1] Nature could have had the ovum develop without fertilization and does so in certain instances. This is called *parthenogenesis.* No new combinations are then possible; there is but one set of genes, weaknesses are not diluted by admixture with another strain and the strain does not endure except in instances, such as the bee and certain other insects, in which parthenogenesis alternates with sexual reproduction. Artificial parthenogenesis is now induced experimentally in certain lower forms of life by stimulating the eggs with chemicals, needles, etc., although development as a rule is not complete.

The Mechanism of Sexual Reproduction.—Nature has gone to a great deal of pains to achieve a living and changing world and to perfect a mechanism of exchange and recombination of hereditary characteristics. Some of her methods strike us as being still somewhat crude and wasteful, but she will doubtless improve upon those within the next few million years, which are but a moment in her sight.

From protozoon to volvox required a long, long period of time. No one knows how long, and scientists who formerly talked in terms of probable thousands of years now speak of millions. From volvox to man has required a similar stretch of time. Nature experimented, apparently in many moods from playful to severe, and always with prodigal disregard of the individual but with jealous solicitude for improvement of the type and the perpetuation of life.

After the sex organs were segregated in male and female individuals many devices were employed for bringing the sex cells together. In plants the pollen grains (male fertilizing cells)

[1] NEWMAN, *op. cit,* p. 186; WELLS, HUXLEY, and WELLS, *The Science of Life,* pp. 448–450, Doubleday, Doran & Company, Inc., 1930; PLUNKETT, *op. cit.,* p. 418; LANE, *op. cit.,* p. 456.

are carried to the female cell by wind, insects, birds, etc., in the colorful, fragrant ways so familiar to us.

In the case of most fishes, the female at spawning time seeks a warm and shallow spot and deposits her eggs, literally in thousands. In obedience to some obscure attraction the male fish follows and deposits sperm cells by millions over the spot where lie the waiting eggs. In spite of enormous waste many of these cells do unite and produce young fish who must do for themselves without maternal care from the moment of their birth.

In the case of birds Nature effected a great saving by having the sperm cells deposited by the male directly within the body of the female, thus the egg is fertilized before leaving her body. Since the robin produces perhaps a dozen eggs in a season, whereas a cod will produce millions, Nature causes the parent birds to take great care of these and of the young who come from them.

In mammals still greater saving was effected by having the egg both fertilized and incubated within the female body. As the mammalian animal becomes more complex or highly developed, the period of incubation before birth and of helplessness after birth lengthens and the number of young produced becomes smaller. From protozoon to man, however, the basic mechanism of reproduction is the same; cell division and separation through the marvelous chemical mechanisms here described.

The Meaning of Sex.—With the creation of two sexes, sex attraction appears, followed later by an equally powerful socio-biological force integrating the interests of parent and offspring. In previous chapters attention has been called to the fact that social relationships produce chemical reactions and actually modify bodily organic function. It seems to be an actual fact that living things do not influence each other unless chemical changes are produced. The converse is equally true. Injury or removal of certain glands which manufacture potent chemical secretions (such as the pituitary), or the omission of certain essential chemicals, such as vitamin E, from the diet of experimental animals may entirely obliterate sex emotion and attraction and even change them to repulsion. The removal of certain chemicals, notably manganese, from the diet of a mother rat may cause her to lose all maternal solicitude and even to devour her young.

When in the economy of Nature it becomes necessary for fertilization or union of differing sex elements to occur, sex attraction becomes as powerful, as essential, as orderly, and as lawful as is the cohesive, integrating force which holds together the structure of molecule or atom. Scientifically speaking (and thinking), one physiological hunger is as legitimate and as decent as another—sex hunger is no more moral or immoral than food hunger. In the instance of sex hunger, however, a social factor of great significance is introduced because the cooperation of a second free individual is involved in the satisfaction of the craving, and the biological implication of helpless progeny endows the sexual act with tremendous moral significance.

With the cessation of growth, *i.e.*, with physical maturity, and the onset of the functioning of the sex glands, now manufacturing potent new chemicals, specific physical tensions arise, accompanied by local congestion which can only, or at least most effectively, be relieved by the sexual act. Civilized social custom has imposed restraint and delay in the exercise of the sexual function during the premarital life which compels the conventional individual to seek relief for organic sex tension and congestion in other intensive interests and activities. This is called *sublimation.* Seminal emissions spontaneously relieve the male to a certain extent. Mental attitude modifies the situation to a considerable degree in both sexes. The individual who has wholesome physical activities and many intellectual interests sublimates more successfully than one less fortunately equipped. In obedience to the laws of rhythm which seem to operate throughout cosmic organization there is fluctuation or periodicity in the appearance of these tensions. Spawning time for fishes occurs with predictable regularity. The tensions of the female are relieved when she deposits her eggs in some warm and shallow quiet pool. The warmth and the quiet may facilitate the release of the eggs from the oviduct, or there may be some as yet obscure instinct which leads her to select a spot favorable to the survival of the young. There arise in the male at this time corresponding tensions and an inclination to follow the female. The discharge of the seminal fluid (milt) over the freshly deposited eggs results. The sex life of the fish is then over, and for the time being life becomes again a matter of food and survival with no evidence of

continuing individual interest or even recognition between the parties involved.

In the frog at breeding time the male clasps the female and goes into a "trance-like" state which may last for some days. Under the stimulus of the sexual embrace the female lays her eggs which are then directly fertilized by the sperm of the male. By the time the birds have branched off from the common biological stem a prolonged attraction between the sexes appears, enduring for the entire mating season, and even, in some species, for the life span of the mating pair.

In birds the institution of courtship is well developed, and we see a (to us) ludicrous duplication of the human arts and wiles of retreat and pursuit, coyness and coquetry, and showing off, which are displayed under similar circumstances in the drama of human life.

In birds we see courtship followed by the striking phenomenon of nest building, and we watch in amazement the finally mated pair as they go about their orderly preparation for their forthcoming parental obligations. After courtship has terminated in relief of physical tensions through fertilization and laying of the eggs we see sexual excitement replaced by something resembling tender solicitude as the pair in some instances actually share the task of sitting upon the eggs, while in others the female is fed by the male. When the nest becomes filled with greedy birdlings life becomes very real and very earnest, and both parents are possessed and consumed by a joint emotion of parental solicitude. The parents will wear themselves thin, go hungry, expose themselves to hazards, and even die, in the interests of their young.

Following the period of complete dependency comes a time when fledglings must be taught to fly and to feed themselves. Nothing in living phenomena exceeds the wisdom and skill and solicitude with which the young birds are taught and trained and started upon their mature careers. Then the parents are through! Parents and progeny suddenly are strangers, and, if interests conflict, even enemies.

This picture of courtship, mating, parental devotion, and care of young can be duplicated in a thousand varied forms in animal life,[1] but there is no evidence that any special bond is felt between

[1] LANE, *op. cit.*, Courtship, pp. 314–319; Care of Young, pp. 320–331.

parent and young after the period of dependency is over and the young are able to care for themselves. In the case of the civilized human animal the parental attachment survives the dependency of the young, and is even expanded in a reversal of relationship such that the offspring may care for the parents in the helplessness of old age with a solicitude approaching that of parents for their young.

In the ascent of man in the scale of evolution and civilization the relation of the sexes, with the concomitant and resultant parental relationships culminating in the institution we know as *the family,* has become one of the dominating and motivating emotions of human life. Merely physical sex attraction has been expanded into the mystic and powerful force called *romantic love.* As life has become more complex, emotional (and practical) bonds have constantly arisen out of the complexities and integrated them, forming the unified thing we call *Society.* The rise of the integrating bond of human love in its various phases has created literature and art and romantic love has ever been their major theme.

With the rise of a brain mechanism, which seems designed increasingly to replace and eventually to supplant the non-learned directive force of instinct, humanity in general and this generation in particular finds itself obliged to think its way through a bewildering maze of social emotions, relationships, and responsibilities. Since all of this is but a manifestation of cohesive force in the larger biological organism known as Society, group thinking is involved. The individual cannot think, decide, and act for himself (see chap. IV).

The members of the present generation, because world conditions have undergone complete upheavals and reversals, find themselves faced with the necessity of assigning new values and sanctions to their social experiences such as physical sex relations, sex companionship, marriage, divorce, homemaking, birth control, and parenthood. The new freedom of women in itself has precipitated a new order. The organization of society must expand to provide for the enlarging functions of women. This predicates a new freedom of understanding between the sexes. If this unprecedented frankness is to bring harmony and growth and advancement and survival, and save Nature from the brief

embarrassment and delay of having to wipe out a civilization and begin over again, this frankness must be built upon an intensely scientific attitude of thought. The young men and women who stand midway in the stream of life today and make the momentous decision whether or not there shall be life after them need to be motivated to join the "search for Reality" as their prime objective.[1]

Summary.—The story of life is a serial story, always "continued in our next." As evolution of complex forms of life progresses "the plot thickens," and new and complicated methods appear for continuing life from generation to generation. The simplest method is 50-50 division of parent organism into progeny. Budding enables the parent to produce numerous successive offspring. Sporing, conjugation, hermaphroditism, and finally separate individuals of two sexes bring the installments up to date. We seem to be left (as some authors serve us) under the necessity of making up our own ending and continuing the plot according to our own ideas and desires from this point. Scientific integrity of thinking alone will produce a valid and consistent "next chapter."

Should not boys and girls be brought up to consider sex matters with the same absolute frankness, casualness, and freedom from embarrassment as obtains in their introduction to any other facts of living or any other natural phenomena, such as weather, digestion, politeness, or sleep?

Should not boys and girls, young men and young women, be educated for parenthood coeducationally? Is the time ripe for the initiation of such a venture?

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[1] Dell, Floyd, *Love in a Machine Age*, chap. X, Adjustment to Reality, chap. XV, The Modern Mating Problem, Farrar & Rinehart, Inc., 1930.

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CHAPTER VI

THE ANATOMY OF HUMAN REPRODUCTION

In the dark womb where I began
My mother's life made me a man,
Through all the months of human birth
Her beauty fed my common earth.
I cannot see, nor breathe, nor stir,
But through the death of some of her.

JOHN MASEFIELD.[1]

The Female Organs of Reproduction. *The Pelvis.*—The important organs of the body are cleverly protected within structures of bone: the brain within the skull; the heart and lungs within the thorax; the female reproductive organs within the pelvis (see Figs. 23 and 27). In the instance of the reproductive organs Nature had several problems to solve: (1) protection of these organs from injury by outside force; (2) adaptation to the changes of pregnancy; and (3) adaptation to the size and form of the child.

Protection of Organs.—This purpose has been accomplished by suspending the reproductive organs across a basin-like arrangement of curving bones called the *true pelvis.* The basin is guarded by the projecting hip joint and also by the flaring rim which forms the *false pelvis.* The massive muscles of the hip also help to protect the bones and the contents of the cavity from injury.

Adaptation to the Changes of Pregnancy.—This is secured by the rising of the pregnant uterus out of the true pelvis at about the middle of pregnancy. Thereafter the false pelvis forms a partial support from below, while the elastic but strong muscles of the abdomen (from which Nature thoughtfully removed the ribs in erect animals) furnish support and a degree of protection, and at the same time give the freedom from compression so necessary to free growth of the fetus.

[1] *Selected Poems*, by permission of The Macmillan Company.

Adaptation to the Size of the Child.—This is secured by a curious and striking standardization of the size of the pelvis regardless of the size or proportions of the woman. We find here a partial explanation of the fact that small women give birth to large babies with no greater proportion of difficulty than large women experience. So completely has standardization been effected that the "normal" measurements of the pelvic inlet (upper rim of the true pelvis) and the outlet (lower rim of the true pelvis) are stated in all textbooks on obstetrics (Fig. 24); and very little deviation is found from these, although one woman may weigh 100 pounds and the next one twice as much. The child must pass through the pelvic openings in the process of birth; it is therefore important that the diameters be correct. The longest diameter of the inlet between the true and the false pelvis is the transverse diameter, which is about 5 inches. The longest diameter of the outlet of the true pelvis is the antero-posterior, which is approximately 4.5 inches. This difference between the inlet and outlet necessitates a quarter revolution of the infant's head in its progress through the pelvis. The fact that the outlet is slightly smaller than the inlet makes the last stage of birth the most difficult, but thereby makes premature or accidental escape of the fetus less liable to occur. The shape of the head of the child is very similar to the contours of the pelvic circumferences, which is another striking adaptation.

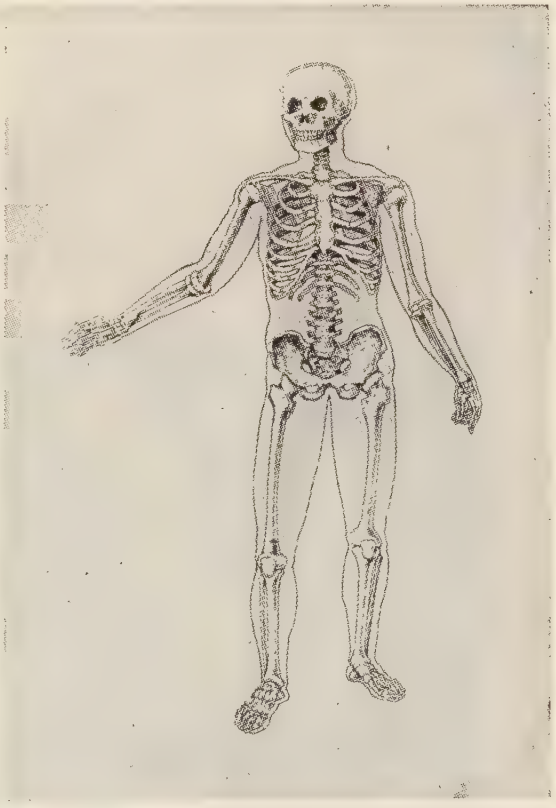


FIG. 23.—Pelvis in situ. (*From Andress, Aldinger and Goldberger, Health Essentials, Ginn & Company.*)

Defects of the Pelvis.—Sometimes the bones of the growing girl child are softened by rickets, or distorted by tuberculosis, or bad posture, or by injury. The diameters may become narrowed in one direction and elongated in another, making it difficult or

impossible for a child's head to pass through the openings. This is one of the complications of childbirth which must be met by the use of instruments to help the child to make the difficult

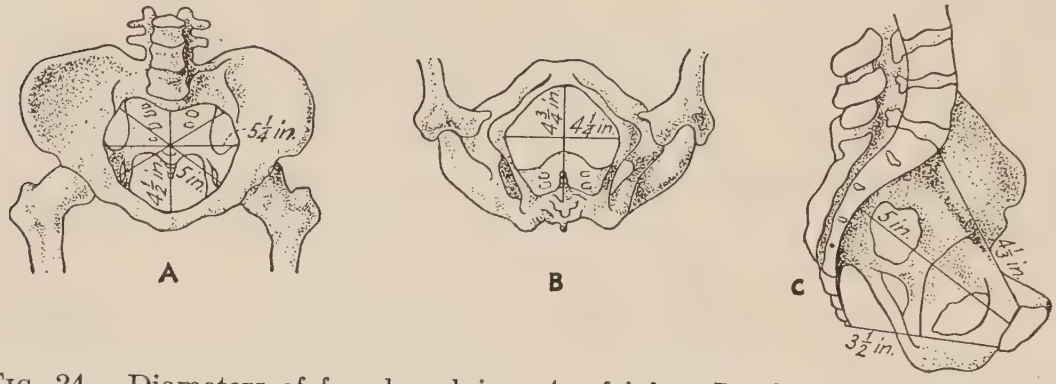
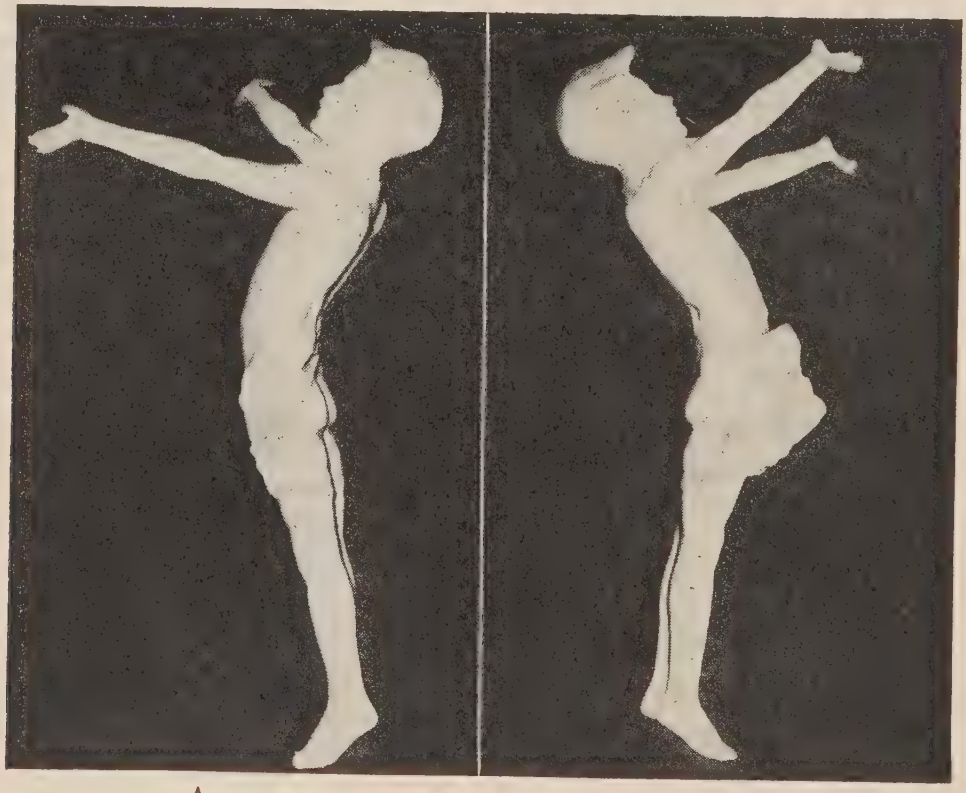


FIG. 24.—Diameters of female pelvis. *A*, of inlet; *B*, of outlet; *C*, the pelvic cavity in cross section.

passage, or in extreme cases by surgical delivery through the abdominal wall. The latter method is supposed to be called



A. B.

FIG. 25.—"The Good Fairy." *A*, the boyish side; *B*, the girlish side. (*By permission of Jessie McCutcheon Raleigh.*)

Caesarean Section because of the tradition that Caesar the Great was delivered in this manner, although the term may be derived from the Latin *caedere*, to cut. It is usually written, however,

with a capital C. The operation is now a safe one for both mother and child when performed by a skillful specialist. It has even been safely performed two or more consecutive times in individual cases.

Pelvic Measurements.—A skillful physician can estimate the size of the various pelvic diameters by certain measurements, which should always be taken as early as possible in the first pregnancy. In this way the doctor can anticipate complications occasioned by abnormalities of the pelvis and be prepared to meet them. A woman known to have abnormal pelvic proportions or abnormally small diameters should always go to the

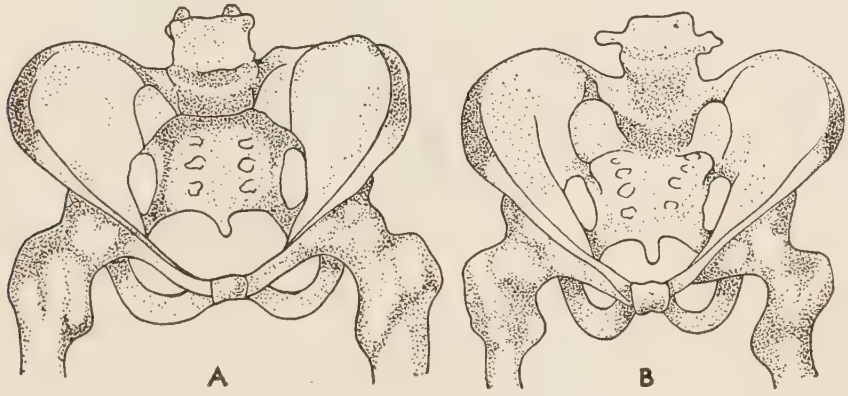


FIG. 26.—Pelves: *A*, female; *B*, male

hospital for confinement in order that the correct surgical facilities may be at hand. When proper and timely arrangements are made and the condition is known before the onset of labor there is no great danger involved in surgical delivery.

In early childhood there is little difference between male and female pelvic skeletons (Fig. 25). With the changes of puberty, however, marked differences appear. The pelvic girdle of the female widens and changes in shape. The outlet of the female pelvis is much larger than that of the male (Fig. 26).

It is important to the maternal function that the mineral metabolism and the nutrition of every girl child be normal throughout all her growing years; that she have vigorous active exercise to facilitate the proper spread and shaping of the pelvic structures; that she observe correct posture in sitting, standing, and walking; and that hampering clothing be avoided.

The Uterus.—The most obvious of the reproductive organs is the uterus (commonly called the womb). This is the living nest in which the human egg passes its long period of incubation.

It is a pear-shaped organ about 3 inches long, flattened from front to back, with the heavy end or fundus directed upward and curved toward the front of the body; the slender portion, the cervix or neck, extends downward into the vagina. The uterus

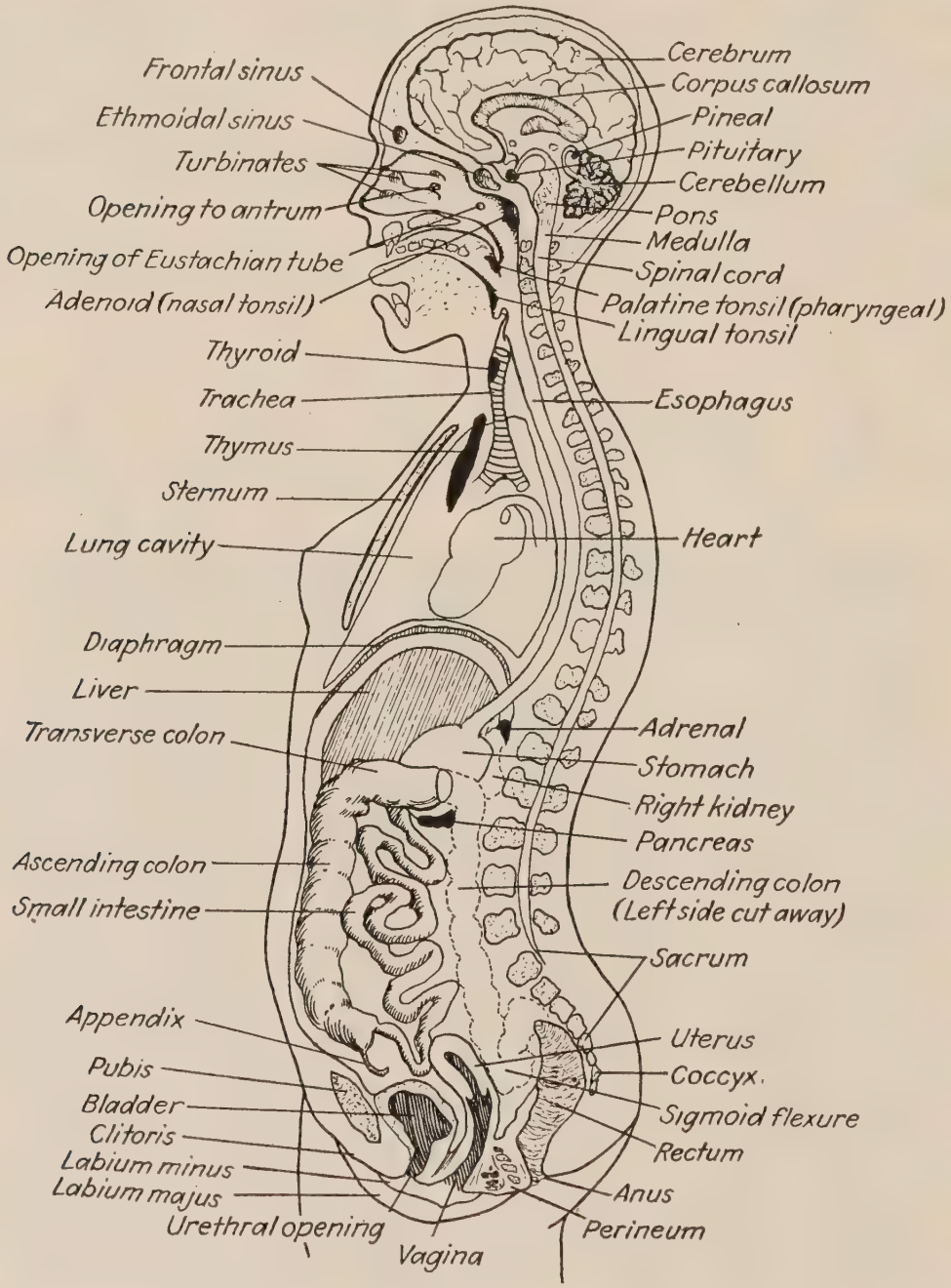


FIG. 27.—Median section of female body.

has a somewhat triangular cavity with passageways leading from the upper external angles of the cavity into the Fallopian tubes. A larger passage through the cervix opens into the vagina.

The nonpregnant uterus is formed of a dense mass of highly elastic muscle fibers and weighs about 2 ounces. It is richly

supplied with blood vessels but very scantily supplied with nerves. During pregnancy the uterus increases greatly in size and changes in shape. Just after the child and afterbirth (placenta) are expelled the loose muscular sac contracts into a hard mass weighing about 2 pounds. During the 5 or 6 weeks following childbirth the uterus returns to its former size and shape. This process is called *involution.* When return to normal is delayed and the uterus remains large and heavy the condition is called *subinvolution.*

The Fallopian tubes or oviducts, commonly referred to as "the tubes," are tube-like structures each about as large as a lead pencil and 4 or 5 inches long. They are continuous with the upper angles of the fundus of the uterus and extend in a curve about the sides of the pelvis, each tube ending in a "fimbriated" or "fringed" calyx-like extremity (Fig. 28). The very small passageway through the tube is lined with ciliated mucous membrane. This membrane appears smooth to the naked eye, but under a microscope it presents a velvety surface covered with pile or minute projecting cilia. These cilia are always in motion like a wheat field in the wind. As is the case with most of the mucous membranes lining the body cavities, this weaving or wave-like movement is always toward the exterior, and it slowly carries the ovum or egg into the uterus (see Fig. 37, page 146).

The ovaries are the essential organs of reproduction in that they contain the female germ cells or eggs. These two glandular organs are oval in shape and about 1¼ inches long. They are situated just below the tubes, near the fundus, and are loosely attached to the uterus and tubes by small ligaments. There is no opening between the ovaries and the tubes or the uterus. This complete isolation of the ovaries serves to protect them against infection or injury. The ovary consists of two important functioning parts, the *germ cells* (*ova*) and the *interstitial, glandular cells* which probably manufacture an internal secretion.

The vagina is a very elastic collapsible muscular sac or passageway about 3 inches long located between the os (mouth) of the uterus and the external world. It is normally and usually collapsed and empty except for a small amount of mucous secretion, which is antiseptic and protects the parts from infection and injury. The special function of the vagina is to serve as a recep-

tacle for the spermatic fluid from the male. Although ordinarily empty and small in size the vagina stretches sufficiently to permit the passage of the child at birth.

The Ligaments.—The uterus, tubes, and ovaries are loosely suspended from side to side of the pelvis by a fold of connective tissue called *the broad ligament.* This is a continuation of the peritoneum covering the intestines. It should be remembered that all abdominal structures are covered with peritoneal mem-

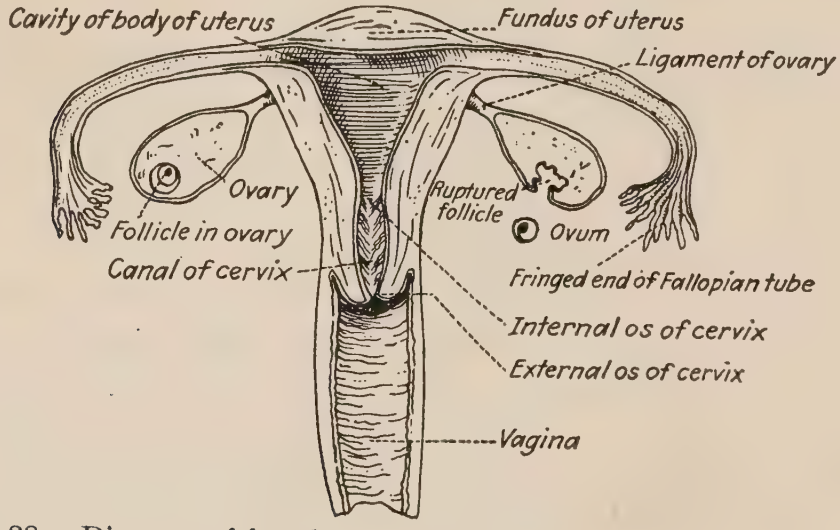


FIG. 28.—Diagram of female reproductive organs seen from the front.

brane, much as if one huge piece of tissue paper were used to wrap and separate, in its successive folds, a number of objects packed in a box. One such fold separates the bladder from the other organs. The broad ligament is really a somewhat thickened fold of the continuous membrane. This arrangement is protective and tends to prevent one organ, if infected, from transmitting infection to other organs. The uterus is further anchored by two cord-like *round ligaments* attached to the upper angles or "horns" of the uterus, which pass across the pelvis and come out through a loose place between the muscles and ligaments in the groin called the *inguinal ring* and are attached to the muscles and connective tissue which form the *mons veneris.* The large nerves and blood vessels supplying the leg also pass out of the pelvis through this ring. A loop of bowel is sometimes forced through this aperture, producing what is known as inguinal hernia or "rupture." The testicles of the male child pass through the inguinal rings into the scrotum some time before birth.

Several other ligaments anchor the uterus loosely to the sacrum behind and the bladder in front. These are all somewhat elastic and become elongated during pregnancy to permit the uterus to rise into the abdomen.

Relation to Other Pelvic Structures. *The Bladder.*—The uterus and attached parts lie behind the urinary bladder (Fig. 27). The peritoneal membrane completely separates the bladder from the reproductive organs. This protects each from infection occurring in the other. The uterus normally curves toward the front and rests against the bladder. As the size and position of the bladder vary greatly according to the amount of urine it contains there is almost constant change in the relative position and curvature of the uterus.

The Bowel.—The rectum lies directly behind the uterus, and the loops and folds of small and large bowels closely surround the reproductive organs (Fig. 27). Constipation may interfere with free circulation and good tone of these organs, and may be a cause of painful menstruation; pressure of a pregnant or a displaced uterus may also cause constipation or hemorrhoids.

Blood Vessels and Nerves.—The trunks of the large spinal blood vessels and nerves branch and cross the floor of the pelvis on their way to the inguinal ring in each groin. The pregnant uterus or a displaced uterus may press upon these and may cause swelling of the feet, varicose veins, muscle cramps, and hemorrhoids (see pages 226–228).

The External Genitals.—The region between the thighs and extending from the pubis to the rectum is known as the *vulva* or external genitals (Fig. 29).

The mons veneris is the elevation over the pubic portion of the pelvis which is covered with hair after puberty.

The Labia.—The *Labia Majora* (large lips) are the protective folds covered with hair on the outside which enclose the elliptical space. Inside of the large lips are smaller folds called *Labia Minora* (small lips). These are supplied with numbers of secretory glands. Taken together the labia cover and protect the delicate structures and openings of the vulvar space.

The Clitoris.—At the anterior angle of the small labia is a small sensitive structure called the *clitoris.* This is buried beneath the skin except at its posterior end. The exposed portion

is erectile and is the seat of sexual sensation. In its origin and structure it corresponds to the erectile structures of the male penis (Fig. 31). Sometimes the sensitive end is covered by the folds of the labia (the prepuce) and is said to be "hooded." This corresponds on a very small scale to the condition in the male which requires circumcision. It is sometimes necessary to separate the adhesions covering the clitoris, as secretions collect behind the prepuce and become irritative. When any girl child shows signs of irritation or discomfort in this region which cannot be otherwise accounted for she should be examined by a physician and if necessary this very trivial operation should be performed.

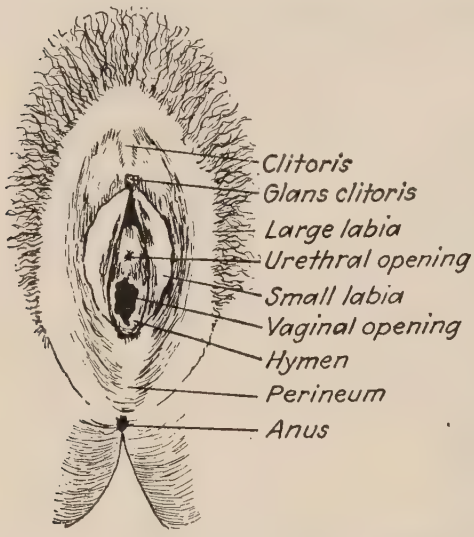


FIG. 29.—The external female genitals.

The Openings.—The *meatus urinarius* or urethral opening from the bladder is situated just behind the clitoris. The *vaginal* opening is found directly behind this. Both of these openings lie in a depression called the *vestibule.*

The Hymen.—The "maiden-head," as it is sometimes called, is an irregular covering of membrane which surrounds the vaginal opening and forms the floor of the vagina. The hymen appears about the third month of embryonic development. Sometimes the hymen is little more than a vestige, sometimes it almost completely covers the space with only a very small opening. Cases are on record in which there was no opening in the hymen, a condition which was discovered when menstruation began. The hymen is stretched or ruptured on the occasion of the first sexual intercourse. The intact condition of the hymen was formerly taken to be evidence of virginity. It is now known that there are many instances of vestigial membrane, and this with other reasons combines to make this unreliable as a legal or social test. Premarital medical examination may include clipping or stretching of a thick or unyielding hymen under local anaesthetic if indicated and desired.

The Perineum.—Between the vaginal opening and the rectum is a mass of muscles called the *perineum.* The fibers run in different directions and form a very firm, strong support or floor for the contents of the pelvis. Sometimes the contractions of the uterus at the time of the expulsion of the child are strong enough to force the head of the child against the perineum powerfully and tear it. When injury to the perineum occurs it should be repaired before the doctor leaves the patient. The operation is quite simple, since in a labor so difficult some anaesthetic will have been used, the parts are already sterile, and

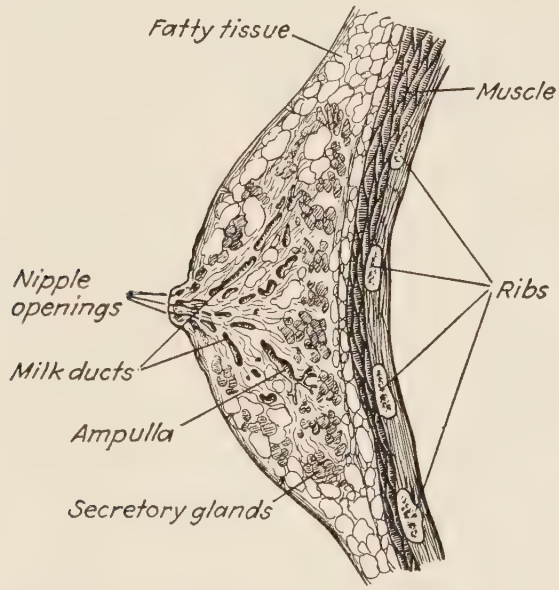


FIG. 30.—Diagram of the structure of the mammary gland.

everything is at hand for taking the one or more stitches which may be necessary. The vulva is to be dressed with sterile dressing and the woman is to be in bed anyway for a sufficient time for the necessary healing. If repair is not made the loss of support may cause a "bearing-down," "dragged-out" feeling, and produce semiinvalidism which can only be cured by later going to a hospital for a reparative operation. It is now considered inexcusable for a doctor to neglect this important matter. Fortunately also, modern obstetricians are able, in most cases, to prevent accident.

The Breasts, Mammary Glands, Mammae.—The secreting structures of the breast (mammary gland) consist of grape-like clusters of glands which take substances from the blood and make them into milk. The milk flows through the twig-like

ducts into the larger ampullae and is there retained until it is withdrawn by the mouth of the infant (Fig. 30). After lactation ceases these glands undergo considerable atrophy.

As the mammary glands are situated at considerable distance from the reproductive organs it has always been a mystery why milk should be secreted just when the baby was ready to use it. The discovery of internal secretions has cleared up this as well as many other "mysteries." The development of the breasts at puberty is stimulated by the internal secretion of the anterior pituitary and other glands. The changes in the breasts which are characteristic of pregnancy are especially stimulated by two glandular organs which are created for the duration of pregnancy only, the *corpus luteum* and the *placenta* (afterbirth) (pages 116 and 121).

The nipples are surrounded by a pigmented area which darkens during pregnancy. Sometimes the nipples are small or even inverted or retracted. This condition should be treated during pregnancy, as it sometimes makes nursing difficult.

The Male Organs of Reproduction.—*The scrotum* is the sac of muscular and connective tissue which contains and protects the testes. It corresponds to the large labia in the female. It is highly elastic and contractile. If bruised or injured it may fill with fluid causing what is known as varicocele. Male infants should be protected from pressure and irritation from tightly adjusted diapers. Older children may injure themselves in sac swings and other injudicious sports.

The testicles (*testes*) are the essential reproductive organs in the male, corresponding to the ovaries of the female. Indeed, they originate within the pelvis and only "migrate" or leave it shortly before birth, when they slip through the inguinal rings and enter the scrotum. This is called the "descent of the testicle." Sometimes this descent does not occur until after birth. The testes are slightly larger than the ovaries, about $1\frac{1}{2}$ by $1\frac{3}{4}$ inches. The testicle is filled with a very long coiled *seminiferous tubule* within which the *sperm cells* develop as do the ova in the ovary. The tubules are surrounded with interstitial gland-cells which may be similar in function to those in the ovary. The internal secretion of these interstitial cells probably has something to do with stimulating the formation of the secondary sexual characteristics at puberty such as the growth of hair, change of voice, etc.,

and with maintaining sexual and mental vigor throughout life. The anterior pituitary, however, seems to play the major rôle in this (see page 114).

The sperm cells (*spermatozoa*) are developed in incredible numbers within some 1,500 feet of tubules in the testicle. When fully matured the spermatozoon is one of the smallest cells in the body. The male child at birth is provided with millions of potential reproductive cells. After puberty these are maturing con-

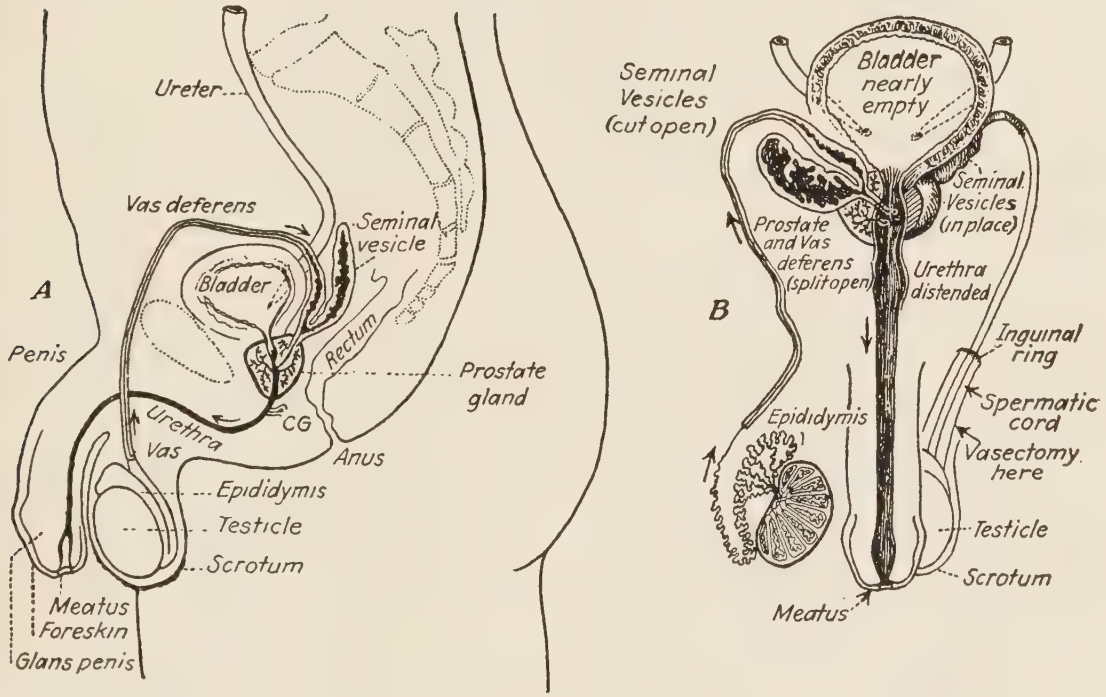


FIG. 31.—Male organs of reproduction. *A*, from side; *B*, from front (structures on the left laid open). (*From Dickinson and Bryant, Control of Conception, Williams & Wilkins Co.*)

stantly within the seminiferous tubules and are discharged at intervals from the testes through the *spermatic duct.*

The spermatic cord is formed by the time the testes descend. It corresponds to the Fallopian tube or oviduct in the female and contains the spermatic duct (vas deferens), blood, and lymph vessels and nerves. It is very long, extending from the testicle through the inguinal ring to the seminal vesicles behind the bladder where the spermatic fluid is added. From the seminal vesicles the spermatic duct continues as the *ejaculatory duct* and carries the *seminal fluid* and sperm cells through the *prostate gland,* where the duct joins the *urethra,* and the fluid is discharged through the penis in sexual intercourse or in seminal emissions.

The Penis.—The male organ of copulation (sexual intercourse) is the penis, which is situated above the scrotum in the position corresponding to the clitoris in the female. This organ is composed of three cylinders of highly erectile tissue, one of which ends in the sensitive glans penis, the specific organ of sexual sensation in the male. The urethra also traverses the penis and conveys both seminal fluid and urine to the exterior.

The glans is covered and protected by the circular fold of skin at the end of the penis called the *prepuce or foreskin.* This is normally very loose and elastic and easily slips back exposing the glans. Sometimes the prepuce is adherent to the glans; sometimes the opening is very small, so small as to interfere with free discharge of urine. In this case secretions collect under the foreskin and become irritative. In the infant fretfulness, wakefulness, and in extreme instances convulsions may result. In older children nervousness, irritability, masturbation (handling the genital organs), and impairment of nutrition result. Retention of urine may lead to toxemia. *Circumcision* (surgical removal of the excess tissue of the foreskin) is then indicated and when needed should be done as early as possible. Every male child should be examined at birth by the physician and if this condition (called *phimosis*) exists, circumcision should usually be performed within a few days or a few weeks.

The foreskin of the male infant should be gently retracted and the glans cleansed with a bit of cotton at the time of the daily bath. This keeps the prepuce elastic and prevents irritative secretions from collecting about this sensitive structure.

The Origin of the Reproductive Organs.—We have seen that nature elaborated the scheme for the perpetuation of life which we see in human reproduction, step by step over long ages of time as measured in human experience. We might expect to find some record of this in the embryonic development of the child, and surely enough we do (Fig. 32).

When the human embryo is only 2.5 millimeters long ($\frac{1}{10}$ inch, after 3 or 4 weeks of growth) large primordial germ cells can be distinguished in the ectodermal layer. These migrate to a certain center which proceeds to form the genital fold or thickening. At 12 millimeters (about $\frac{1}{2}$ inch, at about 6 or 7 weeks) the primitive genital gland is formed.

While the centers or gradients from which the various reproductive structures are to come appear in rapid sequence, the organs remain indifferent sexually until between the second and third

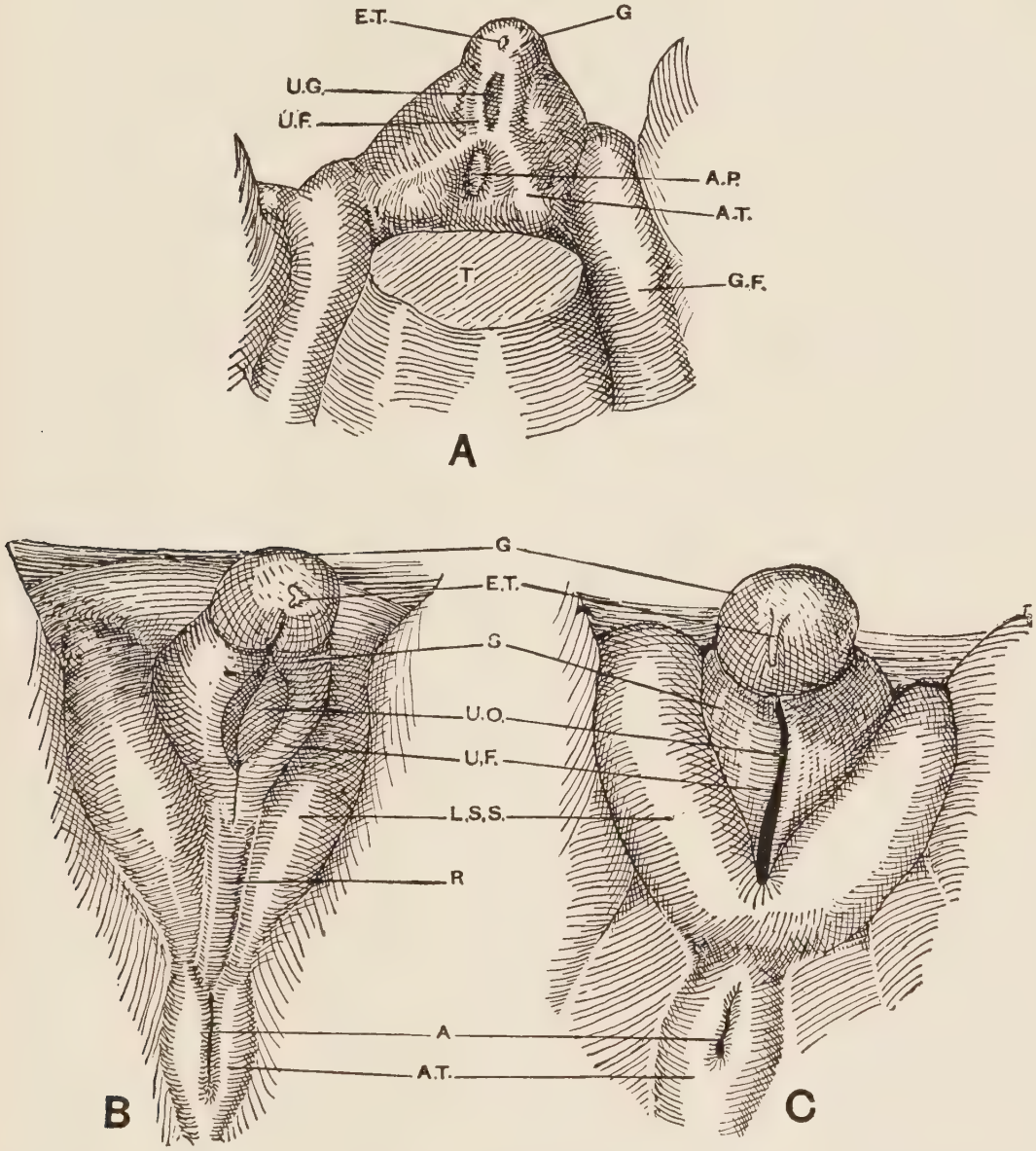


FIG. 32.—A, drawing of external genitalia of an embryo of 16.8 mm, showing the genital tubercle from below; B, external genitalia of a male embryo of 45 mm; C, external genitalia of female embryo of 49 mm. (After Spaulding.) A, anus: A.P., anal pit at the bottom of which lies the anal portion of the cloacal membrane; A.T., anal tubercle; E.T., epithelial tag, which later disappears; G, glans of penis and clitoris; G.F., gluteal fold; L.S.S., labio-scrotal swellings: R, raphe; S, shaft of penis and clitoris; T, tail; U.F., urethral fold: U.G., urethral groove; U.O., urogenital opening. (*After Wieman, An Introduction to Vertebrate Embryology.*)

month of intrauterine growth. During this month the embryo grows from about 1 inch to 1½ inches in length. There is a projection called the "glans of phallus" which in the case of the

male will develop into the penis, and in the case of the female will become the clitoris.

Back of this is the "genital swelling" which, if the child becomes a male, will form the scrotum or protective covering for the testes. If the child becomes a female this will develop into the labia, or folds of protective tissue covering the open cavities which soon form between the vagina and bladder and the outer world.

The essential organs of reproduction, the testes in the male and the ovaries in the female, arise from the same gradients or centers of growth, and in each sex the primordial germ cells containing the hereditary or germinal material become segregated within these oval glandular organs. In the case of the male the testes migrate through the inguinal rings into the scrotum after about seven months' intrauterine development, carrying with them a portion of the peritoneal covering known as the tunica vaginalis. In the case of the female this develops into the vagina.

These few details are mentioned to show a little more of the experimental method of Nature. She rarely produces an entirely new thing; she merely adapts and varies and develops the new from the old with incredible patience and precision.

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CHAPTER VII

THE GLANDS OF INTERNAL SECRETION

The humors in the human body now rage fiercely like the leopard, now more sluggishly like the crab, now proceed in other ways analogous to the wolf or deer or bear or serpent or lion.—E. L. THORNDIKE.[1]

The human body is a marvel of fine and intricate adjustments between complex chemical and structural mechanisms. The single-celled organism assimilates and eliminates and respires through its surface membrane, and very simple mechanical arrangements suffice to convey these processes to and from the interior of the cell. With increase in the size and complexity of the living organism devices became necessary for integrating and coordinating (aligning) the various parts of the body with each other. We find these needs met throughout the entire reach of animal evolution by the rise of three particular mechanisms or systems: the circulatory or transportive, the nervous or communicating, and the endocrine.

The *circulatory system* maintains the chemical balance and supplies the body tissues with ready-to-use fuel and building material for growth and activity. The digestive factories (chemical laboratories), the liver, stomach, pancreas, and intestines, unload their products into the transportive blood vessels at the various assimilative "wharves"; the lungs force oxygen into the blood stream; the food and oxygen are then carried by the blood and lymph vessels to the smallest, outermost body cell with inexorable regularity and uniformity.

The nervous system, with its autonomic and cerebro-spinal divisions, reaches not only the remotest cell but the smallest capillary of the smallest blood vessel, and keeps all parts of the body in close and instant communication.

The endocrine system of glands of internal secretion comprises a chain of special chemical laboratories which also reach every cell

[1] *History of Magic and Experimental Science,* The Macmillan Company, 1923.

and part through the transportation (circulatory) system into which they filter their highly specialized secretions. The chief function of the endocrines is such regulation of the use of the food and oxygen delivered to the tissues by the circulation as will actually secure coordinated growth, activity or "behavior," and reproduction. The internal secretions may be said to be chemical reagents which control the intricate chemical reactions of the body.[1] How much these potent glandular centers of chemical activity have to do with organic alignment and function we shall see throughout the various subjects we are about to study. Indeed, certain of the endocrine glands have so much to do with the conception, and the growth and development of the child before and after he is born that it is impossible to proceed without some consideration of these glands and some of their more important activities.

Much of the work of the body is carried on by glands and glandular organs. *Glands* are organs which take chemical substances from the blood by selective filtration or osmosis and make new substances out of them for specific uses in the body. Glands are now classified as: (1) *glands of external secretion*, which discharge their products into body cavities or on surfaces through ducts; and (2) *glands of internal secretion*, which release their secretions only by filtration into the blood and lymph vessels found in the structure of the gland. In the first class the secretions are easily collected and studied, as in the instance of salivary or gastric or sweat glands. In the second class the secretions must be extracted from the gland itself or from the blood or lymph or other fluids which have received the secretion. The glands of internal secretion are also called *endocrine glands* (from a word meaning "to separate within") and *ductless glands*.

All internal secretions stimulate or restrain the activity of other organs. They are accordingly often called *hormones* or *chemical messengers*. The word hormone literally means "arousing to action." More recently the internal secretions which restrain or check the activity of other organs are being called *chalones* or *depressors*, to distinguish them from *hormones* or

[1] *Science*, Jan. 25, 1929, pp. 85–86; Howell, W. H., *Textbook of Physiology*, p. 897, W. B. Saunders Company, 1931.

excitors, and the term *autacoid* is used as the collective term. The term hormone is still used in both the general and specific senses, hence one should note in reading which meaning is implied.

Some internal secretions have been isolated and their chemical formulas established, and they are now used medicinally in synthetic or artificial form. Adrenalin from the adrenal glands, thyroxin from the thyroid, pituitrin from the pituitary glands, are examples. Others have not yet been isolated and are known only by their effects, and are used in the form of "organic extracts." The amount of some of these secretions is incredibly small, but they have almost incredible potency. "The total mass of human endocrine glands all rolled together would form a parcel small enough to go in a waistcoat pocket," but we are told that growth, function, and life itself depend upon their activity.

The various internal secretions are constant throughout animal series having glands; thyroid secretion, for example, having the same composition and action whether obtained from a frog, sheep, monkey, or man.

One of the interesting things about these glands is their relationship to each other. They form a real "system." Their activities are adjusted to each other and to the other organs of the body as are the parts of a machine, stimulating and checking each other and achieving, in a condition of health, a perfect balance or alignment in operating efficiency, and a perfect adaptation of the mechanism to environmental conditions. They help maintain the organic balance of the body, which is only another name for health.

Harrow likens the endocrine system to the well-organized headquarters staff of an army;[1] Williams and Hoag to an orchestra in which each gland is an instrument, the thyroid the first violin, the pineal the viola, etc.; and all instruments must be tuned in harmony, whereupon they may play many melodies;[2] while Berman terms them an "interlocking directorate."[3] Pro-

[1] Harrow, Benjamin, *Glands in Health and Disease*, E. P. Dutton & Co., Inc., 1922.

[2] Williams and Hoag, *Rest and Grow Strong*, chaps. XVIII–XXV, Bobbs-Merrill Company, 1925.

[3] Berman, Louis, *Glands Regulating Personality*, The Macmillan Company, 1928.

fessor Heinrich Poll of Hamburg says that the interrelationship and adjustment between insulin, adrenalin, and the sex hormones may even be expressed in mathematical formulas. There seems also to be some evidence that there are definite rhythms or rates

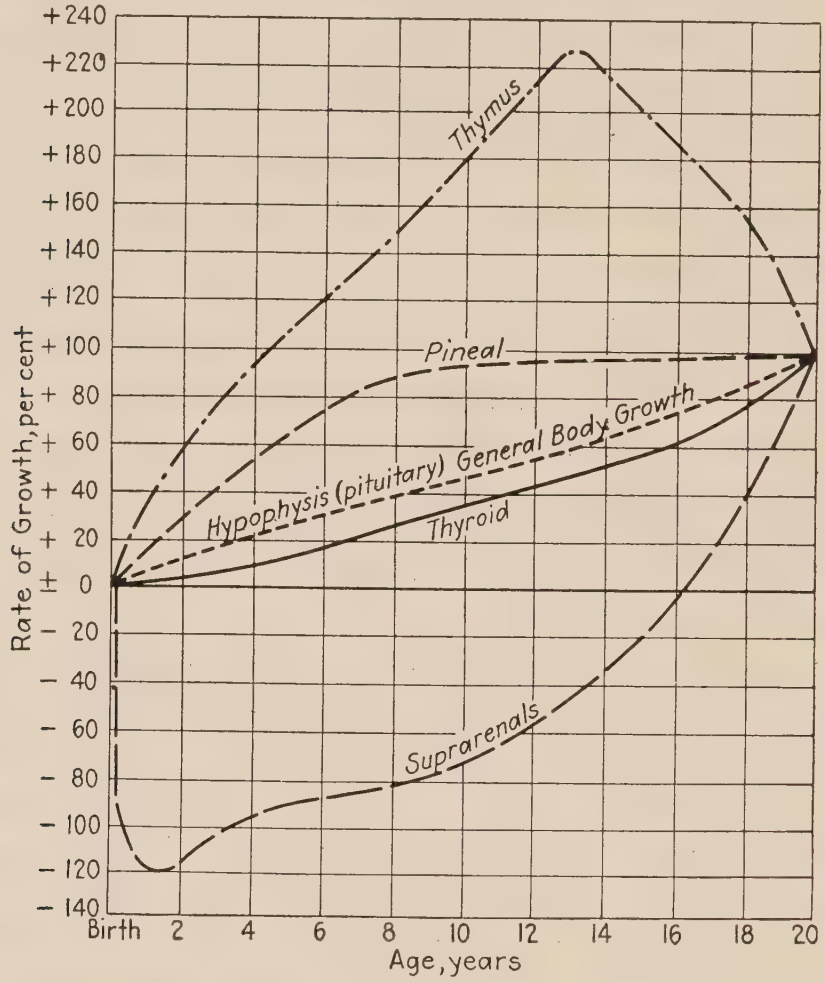


FIG. 33.—Growth rate of five glands of internal secretion. (*From Scammon, Growth of Man, University of Minnesota Press.*)

of growth for the various endocrines and that these are interrelated (Fig. 33) and may come to be expressed in a formula for a given age, such as "the adrenal-thyroid quotient for six years," etc.[1] So intricate is this relationship that it is difficult entirely to separate the specific actions of the glands, since they affect each other as well as the various other organs of the body.

[1] FETRICK, MAJANS, MONASSOHN, Endocrinological Formulae for Children at Various Age Periods, *Jahrbuch für Kinderheilk*, vol. 115, p. 363, 1927 (*Child Development Abstracts*). Also F. S. HAMMETT, A Biometric Study of the Size Interrelationship of the Glands of Internal Secretion, *Journal of Metabolic Research*, vols. 7–8, pp. 91–163, 1925–1926.

The location of the principal ductless glands may be seen in Fig. 27. In the following discussion of the various endocrines, their relations to reproduction and to metabolism, growth, and development will be selected for special mention. On page 123 a table of the chief characteristics and functions of the endocrines is given. It must be borne in mind that the entire subject of endocrinology is very new and that a great deal of active research is in progress. It is impossible to rush a manuscript to print

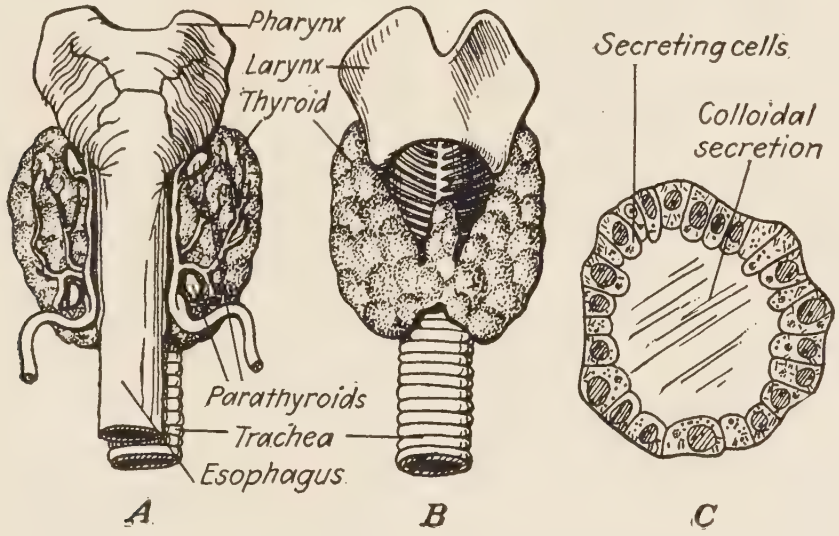


FIG. 34.—The thyroid and parathyroid glands. *A*, seen from behind, showing the four parathyroids and the blood vessels supplying the glands; *B*, the thyroid from the front; *C*, a thyroid follicle greatly enlarged.

speedily enough to be certain that some new and important discovery has not been omitted. The student should constantly check against very late literature upon the subject.

The Thyroid. *Location, Origin, and Structure.*—The thyroid is a bilobed gland which sits astride the larynx and trachea (the air passage) in front of the neck (Fig. 34). It is soft and plastic and normally cannot be felt or seen. The thyroid, in the embryo, grows out of the same area of the endodermal layer (see page 35) which produces the mucous covering of the tongue. The thyroid appears early in the fetal development and functions before birth.

The thyroid gland is made up of many small follicles less than $\frac{1}{250}$ inch in diameter; each follicle consists of a single layer of secreting cells which apparently produce a glue-like (colloidal) secretion and store it in the interior of the follicle (Fig. 34). The cells lie in intimate contact with many capillaries into which

they give the secretion in regulated amount, withdrawing it, as necessary, from the interior of the cell. Harvey says that 3½ times its weight in blood passes through the thyroid each minute.[1]

The secretion of the thyroid is called *thyroxin.* It has been isolated and analyzed and is now manufactured synthetically (artificially) for medicinal purposes. The chemical composition of thyroxin resembles that of tyrosine, one of the amino acids, in combination with iodine.

Function.—We had our biological origin, we remember, in sea water (see chap. I). It is a curious fact that our body fluids have retained approximately the saltiness and iodine content of sea water. The function of the thyroid seems to be to make iodine available to the body cells and fluids in the usable form of thyroxin and thus maintain the iodine balance.

The thyroid is the "great energizer" or "pace setter" for the body. Thyroxin stimulates the other endocrine glands, which deteriorate on the removal or injury of the thyroid.[2] Thyroxin stimulates the growth and function of all organic structures, but especially of the brain and sex organs. If a tadpole is fed with thyroid extract it matures explosively, skipping, as it were, childhood and youth, and becoming at once an adult frog. If the thyroid is removed from a tadpole it will increase in size but remain a tadpole indefinitely, never taking on the characteristics of an adult frog.

Pathology.—The rôle of the thyroid in early growth and brain development is shown by the fact that thyroid deficiency in a child before birth produces a form of physical and mental arrest known as *cretinism,* a type of congenital idiocy which was described far back in history and which was formerly considered to be hopeless. Cretinism may exist in any degree from mere infantilism, in which the child appears to be retarded or younger than his years, down to the shapeless, senseless lumps of flesh found in the back wards of institutions for the feeble-minded. It is now known that this condition can be benefited, sometimes

[1] Harvey, B. C. H., *Simple Lessons in Human Anatomy,* p. 385, American Medical Association Press, 1931.

[2] Hammett, F. S., Studies of the Thyroid Apparatus, *Endocrinology,* October, 1926.

to a spectacular degree, by treatment with thyroxin. The younger the child the more effective the treatment. Every chlid showing signs of cretinism should have thyroid treatment. Where there is lessened thyroid function in the adult a condition known as *myxœdema* may result.

Too little iodine in the food or functional insufficiency in the gland causes the thyroid to enlarge in a vain effort to do its work. This is known as *hypothyroidism* or *simple goiter*, in which the gland may grow to enormous size. The person so affected is sluggish, cold-blooded, tires easily, and has slow pulse and clammy, cold skin. His bodily machinery runs slowly and with difficulty. The basal metabolism is lowered (see Appendix, page 647); the draft in the body furnace is poor and the fuel will not burn well. This condition improves under thyroxin or iodine administration.

There is some evidence of hereditary susceptibility, since certain families in goitrous regions seem to show striking immunity and others striking susceptibility to thyroid enlargement.[1]

Too much thyroxin or *hyperthyroidism* produces the opposite effects; the individual is overstimulated, cannot tolerate heat, has a rapid pulse, muscle tremor, and protruding eyes, and usually shows a slight thyroid enlargement. His rate of metabolism is increased. The draft in the furnace is wide open and the body fuel is being consumed too rapidly. This occurs in the disease known as *exophthalmic goiter*, sometimes called "inward goiter," also "Graves' Disease," which may be primarily a disease of the autonomic nervous system involving derangement of the thyroid and other glandular functions.[2]

Since the thyroid is "the link between sex and brain," and has much to do with the development and function of the sex organs, it is apt to enlarge slightly during puberty, especially in girls. Unless there are symptoms of hypo- or hyper-thyroidism this need cause no alarm; it is usually purely physiological and due to the increased activity of the gland at this time, and tends to disappear when menstruation (ovulation) is fully and regu-

[1] Shivers, M. O., *American Journal of Surgery*, September, 1929.

[2] Marine, David, *Chemistry in Medicine*, pp. 293–294, The Chemical Foundation, Inc., 1928.

larly established. The gland may also enlarge slightly during normal menstruation and pregnancy.

In order that the thyroid may provide the body with iodine in usable form, a certain amount must be supplied in food. In certain regions known as *goiter areas*, where the iodine left by the sea has been leached out of the soil and is absent or diminished in water and vegetation, hypothyroidism or simple goiter abounds. It has been found that the routine administration of iodine or thyroxin to school children will prevent this by providing the essential growth stimulus to the body and brain.[1]

How important the thyroid is to the metabolism of growing young animals is illustrated by the experimental work of Kunde and Williams, who removed the thyroids from rabbits and rats soon after birth. Although fed upon normal diets rich enough in vitamins to protect normal animals, the animals developed symptoms of rickets, pellagra, xerophthalmia, and cretinism, indicating that the balance of the metabolic mechanism of the body was seriously impaired.[2] This result suggests that some cases of malnutrition in children may be due to endocrine insufficiency or imbalance.

The Parathyroids. *Location, Origin, and Structure.*—The parathyroids are four (sometimes more) tiny glands about the size of grains of wheat, together weighing about 2 grams, which arise out of the third and fourth gill clefts of the embryo (see page 31). They lie upon the posterior surface of the thyroid (Fig. 33) and they are enclosed in fibrous capsules and richly supplied with capillaries, into which their secretion is filtered.

Secretion and Function.—The secretion of the parathyroids has been isolated and named *parathormone.* The parathyroids regulate calcium metabolism, binding the mineral, so to speak, to the bones, nerves, and blood. Parathormone seems to counteract the effect of a certain toxic product of protein metabolism known as guanidine, which produces excessive nervousness and even convulsions if it accumulates in the blood. It also helps regulate sugar metabolism, having an inhibiting effect

[1] Endemic Goiter among School Children, *Public Health Reports*, vol. 42, No. 52, Dec. 30, 1927, U. S. Public Health Service.

[2] Kunde and Williams, *Proceedings of the Society for Experimental Biological Medicine*, p. 814, 1926.

similar to that of insulin (see page 122).[1] Parathormone, through its regulatory effect on blood calcium, is supposed to help maintain proper irritability of muscle tissue.

Pathology.—If the parathyroids are injured or destroyed, the bones soften, the hair drops out, the animal becomes excessively nervous, develops tetanic convulsions, cannot sleep, and soon dies. In rickets and in shortage of calcium in the food, the parathyroids enlarge, and, it is supposed, compensate or counteract these conditions to some extent.[2] Excessive menstrual bleeding is sometimes treated with parathormone.[3] Parathormone is used in the treatment of infantile tetany, a disease of infancy characterized by convulsions.

The Adrenals.—The adrenals are yellow, cap-shaped glands covering the tops of the kidneys. They are each composed of two parts, the *cortex* or "bark," making up the bulk of the gland, and the *medulla* or "core," arising from different origins and at one time in biological history lying far apart in the body of the animal. The cortex is formed from the same embryonic tissue as the reproductive organs; the medulla is formed from the embryonic tissue which gives rise to the sympathetic or autonomic nervous system.[4] The adrenals have the richest blood supply of any organ in the body, receiving 7½ times their weight in blood each minute.[5]

The adrenals appear early in intrauterine life; during the second month being twice as large as the kidney and consisting chiefly of cortex. This large fetal cortex has something to do with brain development; when it is small or lacking the brain fails to develop.

Secretion and Function of the Cortex.—The internal secretion of the adrenal cortex has been isolated and named *cortin.* As might be supposed from its origin, the cortical secretion influences the activity of the reproductive organs. The cortex enlarges

[1] Kirkpatrick and Huettner, *Fundamentals of Health*, p. 393, Ginn & Company, 1931.

[2] Significance of Parathyroid Hyperplasia, editorial, *Journal of the American Medical Association*, Dec. 8, 1928.

[3] Allen and Goldthorpe, *American Journal of Obstetrics*, March, 1929.

[4] Abel and Geiling, *Chemistry in Medicine*, chap. IV, p. 210, The Hormones of the Adrenal Glands, The Chemical Foundation, Inc., 1928.

[5] Harvey, *op. cit.*, p. 401.

during pregnancy and lactation.[1] Cortin when injected into experimental young animals seems to speed up sex development and maturity in somewhat the same manner as that described for the anterior pituitary and the thyroid. This is not entirely clear, and may be in part an indirect effect due to stimulation by cortin of other glands which produce this action, rather than to a specific action of the cortex itself.[2]

One of the special effects of cortin upon metabolism is its detoxifying effect. It seems to neutralize the effect of certain protein toxins. Histamine, for instance, is 30 times more toxic to dogs without adrenals than to normal animals, and dogs with a single cortex survive until placed on a high protein diet.[3]

Cortin has something to do with the distribution of pigment in the body. Addison's disease, caused by destruction of the adrenal cortex, is characterized by peculiar bronzing of the skin, and has formerly usually been progressive and fatal. Since the isolation of cortin spectacular cures are being reported from its use in this disease.

Cortin deficiency in young animals retards growth. Basal metabolism is lowered by deficiency at any age, and immunity is also lowered.[4]

Secretion and Function of the Medulla.—The secretion of the adrenal medulla has been isolated and produced synthetically. It has various names: *adrenalin*, *adrenin*, and the official name *epinephrine*. Epinephrine, like thyroxin, resembles the amino acid tyrosine in composition. The adrenal medullas are sometimes called the "brain" of the autonomic, vegetative, or sympathetic nervous system. The secreting medullary cells are the so-called chromaffin cells, which are also found in the sympathetic ganglia elsewhere in the body. It may be that these ganglia, wherever found, also secrete adrenalin.

Heightened epinephrine secretion produces the same effect as electrical stimulation of the sympathetic (vegetative) nerve centers. "Adrenin raises the conductivity, temperature, and

[1] Zoethout, William D., *Textbook of Physiology*, p. 428, C. V. Mosbey Company, 1925.

[2] Lawrence and Rowe, *Endocrinology*, January–February, 1929.

[3] Abel and Geiling, *op. cit.*

[4] Hoskins, *op. cit.*, p. 48.

capacity of nervous tissue and the adrenal medulla, while it has the opposite effect on the other tissues. This, it would seem, increases the difference in potential between the different tissues. 'It would appear . . . that the medulla of the adrenal functions as nerve tissue; perhaps it is the brain of the vegetative system, its probable function being to charge up, to energize the vegetative system.'"[1]

The blood contains normally about one part of epinephrin in twenty million. The medullas contain a hundred thousand times this much stored as reserve. Under nervous stimulus such as fear or rage this is fed into the blood stream, whereupon the liver is stimulated to release glycogen (liver sugar), which provides quick fuel for the muscles. The senses of sight and hearing are quickened. The blood mass is redistributed, the bulk going to brain and muscle. More red cells are forced into the blood stream from the spleen and other blood-forming centers, thus increasing the oxygen-bearing capacity of the circulation.[2] The total animal resources are made available for flight or fight, and exertions are put forth which at another time would be quite impossible. Invalids escape from burning buildings; the really furious small boy whips one twice his size. The adrenal medulla is sometimes called "the gland of emergency energy."[3]

There is evidence that epinephrine and insulin are paired against each other as stimulant and check in sugar metabolism.[4]

Epinephrine is used medicinally to check hemorrhage, to raise blood pressure, and as a stimulant to the autonomic nervous system in shock or collapse.

Pathology.—Deficiency in adrenal function is associated with certain types of nervous exhaustion or neurasthenia, mental depression, and insanity. In milder form it shows as a "tendency to worry and weep." The outstanding symptom of general adrenal insufficiency is *fatigability*, a tendency to tire easily

[1] Crile, G. W., New Chemical and Experimental Studies of the Interrelations of the Thyroid, Adrenals, and the Nervous System, *Endocrinology*, January–February, 1929.

[2] Izquirdo and Cannon, Conditions of Activity in Endocrine Glands, *American Journal of Physiology*, April, 1928.

[3] Cannon, W. B., Condition of Activity in Endocrine Glands, the Adrenal Medulla, *American Journal of Physiology*, October, 1931.

[4] Abel and Geiling, *op. cit.*, p. 224.

(there are, of course, many other possible causes of fatigability). Since deficiency in adrenal activity produces or is associated with insufficiency in most of the other endocrines the specific details of much of this effect are as yet uncertain.

Dr. E. B. McCready says in the *New York Medical Journal* (vol. 128, p. 199):

> Functional hypoadrenia is frequently found in adolescents, and is marked by sensitiveness to cold and cold extremities, hypotension, weak heart action, anorexia, anemia, constipation, asthma, and other manifestations, by hypersensitiveness, and by psychasthenia. These patients are unable adequately to meet the demands of ordinary life. Fatigability is a manifestation of the condition, and exertion on sustained effort increases the adrenal depletion. They are emotional, crave excitement, but are fatigued by excitement. Often clever students, their work is sporadic and superficial. Their enthusiasms are intense but short-lived.

Observers of child behavior are beginning to call attention to the probability of endocrine insufficiency as a factor in certain types of behavior, particularly the essentially ineffective types such as the hypo-adrenal types described.[1]

The Pituitary (Hypophysis-cerebri). *Origin and Structure of the Pituitary.*—The pituitary gland is a small gland about the size of a pea situated behind the nose at the base of the brain (Fig. 27). It lies in a depression of bone called the Sella Turcica (Turkish Saddle) in one of the best protected and most inaccessible places in the body. Small as it is, it consists of two parts, of different biological origin and of different effect in the body, with a connecting isthmus of glandular tissue the pars-intermedia. The *anterior lobe* is an independent gland. The pars-intermedia secretes the hormone, *pituitrin*, which seems to be stored in colloidal form in the posterior lobe. These two are usually discussed collectively as the *posterior pituitary*. The posterior gland arises from the ventral side of the fore brain.

Secretion and Function of the Anterior Pituitary (Prepituitary).—It is becoming known that the anterior portion of the pituitary gland, perhaps the size of a split pea, is of enormous importance

[1] Endocrine Imbalance and Mental and Physical Development, *Child Development Abstracts*, vol. 2, No. 3, p. 248; Results of Endocrine Therapy in Behavior Disorders, *Archives of Neurology and Psychology*, April, 1927.

in growth and reproduction. The secretion obtained from the whole prepituitary is known as *tethelin.* However, this is now being separated into two or more distinct hormones; one producing growth, another (possibly several) affecting specifically the sex organs. Several names are being applied to these, but general scientific usage has not yet determined which names shall finally be adopted.

The growth hormone stimulates or regulates general growth by increasing "the specific dynamic action of food substances";[1] it also affects growth by virtue of its stimulating effect upon other endocrine glands. It has been called the "thyroid starter," since the thyroid functions imperfectly or not at all in the absence of the prepituitary. It specifically stimulates the development of bone and connective tissue. The individual in whose secretory mechanism the prepituitary growth hormone is dominant (but not abnormal) tends to be a long, lean, active, efficient, and highly energetic person of great endurance. Overactivity (hypersecretion) of this hormone during the growing years produces the 7-foot giants who are seen in side shows. If hypersecretion does not occur until adult years, only certain susceptible bony structures will be involved, producing a condition known as *acromegaly.* The bones of the head, face, and larynx enlarge. The voice becomes heavy and coarse and the individual presents a startling appearance.

Hyposecretion during the growing years produces retardation of mental and physical growth, even dwarfism. Harrow says, "It seems hardly credible that a piece of tissue weighing one-sixtieth of an ounce . . . should, perhaps, be involved in the production of giants on one hand and dwarfs on the other."[2]

The Prepituitary (Anterior Pituitary) Sex Hormone.—It is now believed that the anterior pituitary is chiefly responsible for the changes of puberty occurring in both sexes. Formerly the interstitial cells of the ovaries and testes were believed to play a rôle in this, but more recent research indicates that the prepituitary plays at least the major part.

The prepituitary sex hormone seems to be divisible into at least three distinct subhormones: The first initiates the periodic

[1] Bugbee, Simond, and Grimes, *Endocrinology,* January–February, 1931.

[2] Harrow, *op. cit.,* chap. LV.

maturing of the ovum within the ovary (ovulation), thus creating the estrous or menstrual cycle. The graafian follicle is stimulated to secrete *folliculin.* Several descriptive phrases are applied to this hormone, such as *the follicular ripening hormone, maturity hormone, the universal sex hormone, the motor of the ovary, the master sex hormone,* etc. This hormone is not to be confused with the "female sex hormone" secreted by the gonads (see page 117).

The second sex hormone stimulates the follicle to become the corpus luteum (see page 118). This may be called the *luteum-forming hormone* and is not to be confused with the chalone, *lutein,* of the corpus luteum itself.

The Ascheim-Zondek Test.—Both of these secretions are produced in excess during pregnancy and appear in the urine and blood of pregnant women. They may be recovered from the urine soon after pregnancy begins, reaching a peak of concentration during the first month after conception, decreasing from then until the birth of the child and disappearing entirely within a week afterward. Two German investigators have standardized a test for pregnancy named from them, the *Ascheim-Zondek test.* This consists in injecting a standardized preparation of urine from the subject into young, immature female mice. If the subject is pregnant, the maturing of the sex organs of the mice is greatly accelerated with precocious ovulation.

The third prepituitary hormone has been recently isolated and is called *prolactin.* This seems to stimulate the development of the mammary glands and prepare them for the secretion of milk, when the check of the placental chalone is removed at the birth of the child (see page 121).[1]

It seems probable that the anterior pituitary plays a part in the regulation of manganese metabolism, which is now known to feature in an important manner in the fertility, milk production, and maternal attitude of experimental rats, but this awaits future confirmation.[2]

[1] Hoskins, R. G., *The Tides of Life,* p. 287, W. W. Norton & Company, Inc., 1933.

[2] McCollum and Orent, Effects of Deprivation of Manganese in the Rat, *Journal of Biological Chemistry,* August, 1931.

The Secretion and Function of the Posterior Pituitary.—The internal secretion, *pituitrin* or *hypophamine*, of the posterior pituitary (which may be secreted by the middle part and only stored in the posterior lobe) is probably released directly into the cerebro-spinal fluid in the ventricles of the brain. It has been isolated and synthesized and is extensively used in medicine. Pituitrin causes contraction of all involuntary muscle, raises blood pressure, increases the concentration of urine and, especially, causes contraction of the uterine muscle. Because of the latter effect it is sometimes used in hastening slow or difficult labor. It is supposed that the posterior pituitary is in part responsible for the initiation of labor at the time of the birth of the child; the details of this await further experimental proof.[1] Pituitrin is used in shock and hemorrhage. This secretion also plays a part in maintaining the salt ratio and water utilization of the body.

The Sex Glands, Gonads.—We have seen that each of the endocrine glands which have been described affects growth and nutrition directly or indirectly, both before and after birth, and that several of them directly affect the growth and development and function of the reproductive organs. There is a group of endocrine glands, however, specifically concerned with reproduction, which are known as the sex glands or gonads, which call for special consideration.

The Male Sex Glands.—Since the rôle of the male in reproduction is brief and relatively unimportant physiologically, we find few specific glandular mechanisms in the male, and these have not been extensively studied. There is evidence that the anterior pituitary produces a maturity hormone which initiates the sex changes of puberty in the male as in the female, possibly in cooperation with the interstitial gland-cells in the testes; the anterior pituitary probably regulates or stimulates the production of sperm by the testes in a somewhat rhythmic or periodical manner. There may be other specific male sex hormones secreted by the prostate gland and other secretory organs.

[1] Parturition and the Posterior Hypophysis, editorial, *Journal of the American Medical Association*, May 28, 1932; Van Dyke and Kraft, The Rôle of the Posterior Hypophysis in Initiation of Labor, *American Journal of Physiology*, September, 1927.

Frank and others think there is probably a universal male sex hormone corresponding to the female sex hormone to be described.[1]

In 1927 Moore and Koch of Chicago isolated a fat-soluble hormone from the testes of bulls which compensates for castration (removal of testes). Funk and Harrow have apparently isolated the same or a similar hormone from the urine of men. They are unable to obtain it from the urine of immature boys or senile men. McCullough in 1932 reported evidence of a chalone, apparently secreted by the sex cells proper in the testes, which inhibits the sex-promoting hormone of the anterior pituitary.[2]

The Female Sex Glands.—Most of the sex glands may be said to be glands of both external and internal secretion. The *gonads* (the testes and the ovaries) produce the sperm and ova as well as their respective endocrine secretions. The placenta nourishes the fetus, but in addition to this produces (or contains) both female sex hormone and a luteinizing chalone. The mammary glands nourish the child, but also produce a luteinizing chalone which holds ovulation in check during lactation.

The Female Sex Hormone.—A mysterious and potent principle known as *the female sex hormone*, also called by various writers *estrin*, *amniotin*, *theelin*, and *folliculin* has been isolated from lower plants such as yeast, and from the ovaries of higher plants; it seems to be widely present in plants, is found in various portions of the animal organism, especially in the *ovarian follicle*, the *corpus luteum*, and *placenta*, and it has been recovered from blood serum, bile, and urine. The specific action of the female sex hormone in the animal is to prepare the lining mucosa of the uterus for the reception and nutrition of the ovum. We have seen that the maturity hormone and the luteum-forming hormone of the anterior pituitary stimulate the ovary to produce the ripened ovum (ovulation), and to form endocrine gland cells

[1] See *Science News Letter*, Apr. 16, 1932, for an account of recent reported discoveries; also, Testicular Hormone, editorial, *Journal of the American Medical Association*, Feb. 27, 1931; Frank, Robert T., *The Female Sex Hormone*, chap. XVI, Summary and Review, Charles Thomas Publishing Company, 1929; and Rowe and Lawrence, The Male and Female Gonads, *Endocrinology*, October, 1928.

[2] Hoskins, *op. cit.*, pp. 187–188.

in the follicle, respectively. The action of the female sex hormone is not to be confused with these.

The female sex hormone (folliculin) is the essential hormone of the follicle which causes in the uterus the early changes preparatory to the arrival of the ovum. The corpus luteum, as long as it exists, continues the secretion of the female sex hormone, and causes the uterus to undergo the premenstrual changes (if fertilization does not occur) and produces the enlargement and vascularization of the uterus and formation of the placenta if pregnancy occurs.[1]

The placenta apparently continues the secretion of the female sex hormone and the corpus luteum gradually becomes less active as pregnancy proceeds. The female sex hormone has been recovered in great concentration from the early chorionic blood vessels (see page 148, development of the placenta). The female sex hormone is much more concentrated in menstrual blood than in the circulatory blood, but is found in increasing concentration in the general circulation during the 5 days preceding menstruation. There is a tremendous overproduction of female sex hormone from the eighth week of pregnancy, as many as 5,000 "mouse units" being excreted daily in the urine.[2] (The female sex hormone extracted from any of the sources mentioned, when injected into immature young animals or into castrated animals or into senile animals, causes congestion and swelling of the uterine mucosa. The dosage has been standardized in terms of "mouse units.")

While the female sex hormone, as has been said, occurs in considerable quantities in almost all vegetable foods, it has little if any effect when taken by mouth. It is effective in experimental research only when injected into tissues or preferably directly into the blood stream. It is fat-soluble and is resistant

[1] Certain investigators claim that the hormone of the follicle and the hormone of the corpus luteum are not entirely identical and have given the name *progestin* to the latter secretion. It is said that progestin is ineffective unless preceded by folliculin (see HOSKINS, *op. cit.*, pp. 204–213).

[2] Frank thinks that thousands of ova which never completely mature produce small amounts of female sex hormone. "All evidence favors the fact that this process of atresia (arrest) produces female sex hormone and plays a large rôle in keeping up the tropic nutrition of the genital tract" (FRANK, *op. cit.*, p. 290).

to heat, acids, alkalies, and catalysts, but sensitive to oxygen and light.[1] The effect produced by the female sex hormone fosters, matures, and stimulates all feminine qualities and attributes, as well as the organs needed for the perpetuation of the species."[2]

The interstitial cells are found between the follicles in the ovary and the tubules in the testicle. They were originally supposed to be merely supporting connective tissue; then for a time it appeared that the interstitial cells were endocrine in function and were responsible for producing the secondary sexual characteristics and changes of puberty. This statement will be found in older texts. Recent study of the anterior pituitary has made it apparent that the ovarian and testicular functions, including the changes of puberty, are in most if not all cases initiated by the prepituitary. This makes uncertain for the present the exact nature and function of the interstitial cells. It seems certain that the interstitial cells do have important endocrine function, but the detail of this awaits further research.

The Graafian Follicle.—The ova (eggs) while in the ovary are contained in delicate capsules known as graafian follicles. These are very small while immature. Once each menstrual cycle one of these follicles, with its ovum, under the stimulus of the maturity hormone of the anterior pituitary, enlarges, approaches the surface of the ovary, reaches the bursting point, and releases the ovum into the abdominal cavity. The follicle is lined with minute secretory cells which, during this process, release the female sex hormone (folliculin, theelin, etc.) into the blood capillaries of the ovary. The female sex hormone, as we have seen, stimulates the lining of the uterus to become congested and soft in preparation for the nutrition of a fertilized ovum.

The Corpus Luteum (Yellow Body).—The follicular gland cells become rapidly converted into yellow secretory cells after the escape of the ovum, and the structure is then known as the *corpus luteum.* It continues to secrete the female sex hormone, but in addition secretes another potent and important water-soluble chalone called lutein (progestin) which restrains or coun-

[1] FRANK, *op. cit.*, p. 293.
[2] *Ibid.*, chap. XVI, p. 298.

teracts the maturity hormone of the anterior pituitary and prevents ovulation while the corpus luteum is functioning.

There is evidence also of a third hormone, *relaxin*, which slightly relaxes the pelvic ligaments and very slightly softens the pelvic structures, permitting some adjustment of the pelvis to the growing fetus.

The corpus luteum of the menstrual cycle is short-lived, as will be seen from the diagram in Fig. 35. If pregnancy occurs the corpus luteum persists for the duration of pregnancy; it is supposed to be the active cause of the cessation of menstruation during pregnancy, since it prevents the anterior pituitary from causing further ovulation. Estrus ("heat," "rut," or sexual attraction in animals) in guinea pigs has been inhibited by the water-soluble extract of corpus luteum for as long as 70 days. When withdrawn, estrus promptly reappeared.[1] This phenomenon is confirmed by many other research workers.

The Placenta.—The placenta appears to continue the production of female sex hormone during the period of greatest demand upon the nutritive mechanism of the uterus. It also may assist in stimulating the growth and development of the mammary glands. The placenta, or some undetermined mechanism of pregnancy,[2] also has a chalone effect in that the breasts do not actually secrete milk until the removal of the placenta. Premature removal of the placenta will cause the milk flow to start, while retention of the placenta, with circulatory communication with the uterus remaining intact, will prevent the breasts from secreting.[3]

Some investigators think the placenta also has a luteinizing effect and assists the corpus luteum in restraining the anterior pituitary during pregnancy.[4] Others are not so certain about this.

The Mammae (Breasts).—In addition to their major function of secreting milk, the mammary glands appear to secrete a luteinizing chalone similar to and replacing that produced during

[1] Stickle and Seckinger, *American Journal of Physiology*, June, 1928.

[2] Hormonal Control of Lactation, editorial, *Journal of the American Medical Association*, Jan. 31, 1931.

[3] Frank, *op. cit.*, p. 60.

[4] Collip, J. B., *Journal of the Canadian Medical Association*, vol. 23, 1930.

pregnancy by the corpus luteum, which restrains the anterior pituitary from causing ovulation during lactation.

While it seems to be the intent of Nature that the mother shall not ovulate or become pregnant while nursing a child, actually a good many women do have a return of menstruation (evidence of ovulation) and may become pregnant during lactation.

The pancreas is a gland of both external and internal secretion. The gland proper is a tongue-shaped organ about 10 inches long lying behind the stomach. It secretes the well-known digestive fluids which are poured through the pancreatic ducts into the intestines. Scattered throughout the gland, however, are minute isolated glandular masses known as the *Islands of Langerhans* which secrete the hormone *insulin.*

Insulin regulates sugar combustion in the tissues. When the Islands of Langerhans fail to function sugar appears in the urine and the sugar-ratio of the blood is increased. This condition, known as *diabetes,* is now treated very successfully with regulated doses of insulin.

The thymus is a large, bilobed gland lying behind the sternum (Fig. 27). The specific functions of the thymus are not yet clear, and no hormone has been isolated. It seems to play a part in growth and nutrition, as it is largest during the most active period of growth and atrophies after puberty. The thymus is said to contain a larger concentration of nuclear proteins than does any other animal structure. Nuclear proteins are especially important in growth. The thymus shrinks markedly under starvation or malnutrition. Its rôle is doubtless exceedingly important, but awaits clarification from future research.

The pineal gland is a tiny body located at the base of the brain (Fig. 27). No hormone has been isolated and its specific action is not clear. It is suspected that it may produce a chalone which retards growth and puberty, but this, like many other physiological phenomena, awaits further investigation.

Summary.—A very elaborate and complicated endocrine glandular mechanism has developed during the evolution of living organisms, which seems to have the special purpose of initiating, regulating, and controlling the activity of other organs and tissues. This mechanism seems to have two general func-

tions: (1) The regulation of growth and metabolism through control of particular metabolic processes, *e.g.*, utilization of salt, water, iodine, etc., and also through general stimulation, *e.g.*, adrenin; or restraint, *e.g.*, insulin; and (2) the regulation of reproduction through (*a*) the mysterious rhythmic action of the anterior pituitary, the "motor of the ovary," which causes the periodical phenomena of ovulation and luteum formation; (*b*) through the abundant provision by the follicle, corpus luteum, and placenta of female sex hormone, which seems to be tonic for the activity of all organs concerned in nutrition of the seed egg and fetus in both the plant and the animal worlds; and (*c*) the check and control of the anterior pituitary by the provision of a "luteinizing" secretion by the corpus luteum and mammae which prevents ovulation under certain conditions, such as pregnancy and lactation.

Evidence of human kinship with all Nature is shown in the discovery of hormones which are of identical chemical composition and physiological effect no matter whether obtained from plants or various animal forms. An illustration of this is the female sex hormone, which is being found to exist in various plant and animal organisms, and in various organic structures. It seems probable that there is an equally widespread corresponding male sex hormone.

The Endocrine Glands

Name of gland	Name of autacoids	Hormone	Chalone	Synthesized	Effect on metabolism	Effect on growth	Effect on reproduction	Effect of hyposecretion	Effect of hypersecretion
Thyroid	Thyroxin	X		X	Regulates iodine, assists in sugar metabolism	"Pace setter," stimulates general growth and especially sex-organs and brain	General stimulant	Simple goiter, idiocy (cretinism), myxœdema, lowered vitality	Over-energizes nervous system, Grave's Disease
Parathyroids	Parathormone	X			Regulates calcium, assists in sugar metabolism, neutralizes protein toxins	Skeletal growth		Tetany, convulsions, acidosis	Osteitis fibrosa (overgrowth of bone)
Adrenal cortex	Cortin	X			Detoxicating	Development of brain, sex; regulates pigment distribution	Speeds up sex development and function	Depression, fatigue, low immunity, Addison's Disease	Explosive maturity
Adrenal medulla	Epinephrin (adrenalin) (adrenin)	X		X	Regulates magnesium(?), assists in sugar metabolism			Low blood pressure, depression, sensitivity to insulin	Furnishes emergency energy
Anterior pituitary	Growth hormone. Sex hormones. 1. Maturity 2. Luteum forming 3. Prolactin, milk forming	X X X X			Regulates manganese(?), calcium, water	Regulates skeletal growth	Initiates puberty and ovulation, stimulates formation of corpus luteum, stimulates maturation of mammary glands	Dwarfism, delays maturity	Giantism, explosive maturity
Posterior pituitary	Hypophysin (pituitrin)	X		X	Assists in sugar water, and salt metabolism		Increases flow of urine, causes uterus to contract, may initiate labor and menstruation	Increased sugar tolerance, obesity, lowered immunity	Emaciation, polyuria (excessive flow of urine), heightened blood pressure

THE ENDOCRINE GLANDS.—(*Continued*)

Name of gland	Name of autacoids	Hormone	Chalone	Synthesized	Effect on metabolism	Effect on growth	Effect on reproduction	Effect of hyposecretion	Effect of hypersecretion
Interstitial glands	?	X ?			May be (?) tonic for all vital processes		Stimulates uterine mucosa, may assist in producing maturity and sex interest		
Graafian follicle	Female sex hormone (folliculin)	X					Causes uterus to prepare for ovum	Sterility	Premature maturity
Corpus luteum	1. Female sex hormone 2. Lutein 3. Relaxin	X X	 X 				Causes uterus to form placenta, restrains ovulation, softens pelvic ligaments, stimulates mammary glands	Loss of fetus	Sterility
Placenta	1. Female sex hormone 2. Luteinizing chalone 3. Mammary chalone	X	 X X				Stimulates uterine metabolism, restrains ovulation, restrains mammary glands	Loss of fetus	
Mammae	Luteinizing chalone		X				Restrains ovulation	Premature return of ovulation	
Islands of Langerhans (pancreas)	Insulin		X		Regulates sugar metabolism			Diabetes	Acidosis—coma, lowers blood sugar
Thymus	?	?	?		Probably regulates nucleoproteins and vitamins	Retards growth	Retards sex maturation?	Explosive maturity?	Circulatory and heart disturbances, collapse, sudden death
Pineal	?	?	?		?	Retards growth	Retards sex maturation?	Explosive maturity	

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CHAPTER VIII

FERTILITY

A childless woman never knows
The rippling way that barley grows,
How cherry trees in budded spring
Begin their frail adventuring.
Only we who once have been
Harvest ground and living kin
To each sunny fruit and flower
In prophetic travail-hour,
Only we may truly know
The miracle of things that grow!

LUCIA TRENT.[1]

Menstruation.—The menstrual cycle resembles a miniature pregnancy and is sometimes called pseudo-pregnancy.[2] Indeed, the menstrual cycle, with the period of fetal development interpolated becomes the pregnancy cycle (Fig. 35). The egg is matured and released and the uterus made ready by the female sex hormone of the follicle, followed and reinforced by the female sex hormone of the corpus luteum. If fertilization occurs the corpus luteum remains in ascendancy and through its inhibiting secretion (lutein), assisted by the luteinizing hormone of the placenta, prevents further ovulation. At the close of both menstrual and pregnancy cycles the uterus expels its contents, in one case shedding the useless congested membranes as menstrual flow, and in the other the highly organized placental membranes with their contents.

While it was necessary in the diagram for purposes of illustration to divide the phases of the menstrual cycle into exact intervals, it must be borne in mind that these divisions are only

[1] *Harvest Ground*, courtesy, *Birth Control Review.*

[2] NOVAK, EMIL, Menstruation and Menstrual Disorders, *Journal of the American Medical Association*, Feb. 4, 1928; WINTON and BAYLISS, *Human Physiology*, pp. 343–346, P. Blakiston's Son & Co., 1931; Menstruation a Pseudo-pregnancy, editorial, *Journal of the American Medical Association*, May 17, 1930.

Day of cycle	1–5	6–15	16–28		Ten menstrual cycles
Phase of cycle	I. Menstruation (or birth of child)	II. Rest, repair (prolonged during lactation)	III. Premenstrual (preparatory)		IV. Pregnancy
Uterus	Bleeding (lochia if postpregnant 10–14 days)	Repair of mucosa (prolonged following childbirth)	Congestion, hyperplasia of mucosa (delayed during lactation)		Formation of placenta
Hormones controlling uterus	Posterior pituitary (?)	Folliculin (female sex hormone)	Corpus luteum hormone (female sex hormone)		Corpus luteum, placenta (female sex hormone)
Ovary (regulated by anterior pituitary hormones)	Regression of old corpus luteum	Maturing of new follicle, (anterior pituitary, maturity hormone)	Development of new corpus luteum (lutein)	Corpus luteum in ascendancy (lutein)	Corpus luteum increases in size and functions until last of pregnancy (lutein)
Ovum (anterior pituitary hormones)	Old ovum escapes with menstrual flow, or child is born	New ovum in follicle; escapes (ovulation) at end of this phase	Ovum in tube (fertilization possible)	Ovum in uterus (implanted, if fertilized)	Develops into embryo and fetus

FIG. 35.—The human menstrual and pregnancy cycles.

relative or average. It is obviously impossible to carry on experimental observations with human subjects. Few ova, either fertile or infertile, have been seen in tube or uterus, and few embryos in the very earliest stages of development. It is well known that the duration of the menstrual phase may vary in length from 2 to 7 days. From such evidence as is available it seems that ovulation usually occurs between the fourteenth and seventeenth days following the onset of menstruation. No one knows how long it takes for the ovum to traverse the tube, but probably 3 to 7 days. All of these intervals doubtless may vary from time to time in the same individual.[1]

The Periodicity of Fertility.—It is obvious that the presence of an ovum in a tube is essential to normal fertilization, and that an ovum is normally present in a tube for a relatively brief number of days during the menstrual cycle. The difficulty of determining this number for any individual case is apparent, especially since variation probably occurs, from time to time, with the same individual, in the length of residence of the ovum in the tube. The duration of the menstrual cycle may vary from period to period with a given individual. When, to these factors of variability, is added the fact that no one knows how long spermatozoa remain alive in the uterus and tubes following coitus, and that estimates vary from 3 days to 3 weeks, it will be apparent that in the present state of limited knowledge it is impossible to predict or control fertility on a basis of "the fertile or infertile periods."[2]

Fertility Control.—The problem of achieving sex companionship without entailing irregular and haphazard parenthood has become one of the major personal and social issues in a generation which finds itself possessed of a degree of personal freedom and personal responsibility unprecedented in human history. The degree of individual emancipation and the abruptness with which "self-direction" has come to pass resemble a social mutation. *The critical feature of the situation lies in accomplishing a proper balance between freedom and responsibility.* It is certainly a crisis in biological evolution—the most dramatic moment in

[1] Dickinson and Bryant, *Control of Conception*, pp. 54, 55, 56, Williams & Wilkins Co., 1931.

[2] Dickinson, *op. cit.*, p. 30, Male and Female Rhythms.

the history of the race—when the human animal stops midway in the stream of life reaching from him back and back in unbroken lineage to the common ameboid ancestor of all earth life, and presumes to say, "I will stop this stream; after me there shall be no more life!" This is a decision to be made only after careful deliberation; it is much more than a personal matter, it is a cosmic matter. By such decisions is the trend of history changed.

Students of social evolution see several forms of reaction to the situation. First, a purely selfish reaction manifesting itself in avoidance of parenthood or a limitation such that the individual pair do not even replace themselves in the population. Secondly, a very serious and sincere group who wish to limit the number of offspring only to an extent permitting them to carry on as creative members of society and at the same time to do full justice to the physical, mental, and social well-being of their children. Of course there is always a third group of conservatives who are extremely useful in preventing changes in social customs from occurring with destructive suddenness.

No matter what is one's belief or attitude toward the subject of voluntary limitation of parenthood, it must be recognized and accepted that prevention of conception as a fairly general practice has probably come to stay. It seems now to be the responsibility of medical science to produce contraceptive methods which are harmless and certain, and the responsibility of educational and social scientists to give the young, who have fallen upon this amazing heritage of freedom, as true a sense of balance, perspective, and responsibility as it is possible for them to obtain.

Contraceptive Methods.—In the early history of our country early marriage with uncontrolled procreation was the rule. Methods of prevention and interruption of pregnancy were crude and dangerous. Human passions were as dominant, and illicit sex relationships between the unmarried occurred as frequently as in any similar period of history, in spite of a rigid moral code. A vicious system of secret nostrum vendors and abortionists arose and the public press became filled with veiled advertisements of drugs and illicit surgical service. With the growth of cities sex vice reached amazing proportions. To meet this appalling situation the so-called Comstock Federal Law was

passed in 1873. At that time even the most enlightened public sentiment did not recognize the existence of legitimate control of fertility. This was due in large part to religious conviction, and in part to the fact that really harmless contraceptive procedures were unknown. The result was that the Comstock law, written with no thought, probably, of interfering with legitimate medical science and practice, made it a legal offense for any person or agency to impart information of a contraceptive character or to ship any drug or device, intended to prevent or interrupt pregnancy, from one state to another. Also, in a laudable effort to suppress vicious and obscene literature, "obscenity" was so defined in the act that it has been interpreted until very recently as applying to medical and sex-education publications of educational and scientific character.[1]

The various states, as usual, passed supportive measures which vary considerably from one state to another, but all originally made the manufacture, sale, or transmission of contraceptive devices or information illegal within the state. Recently certain states have modified their laws, legalizing the giving of contraceptive information by a licensed physician when in his opinion the employment of such procedure is necessary to conserve the health or life of the individual, while in certain states all restrictions have been removed. The Federal law remains unchanged.[2]

In spite of the rigid legal restrictions contraceptive methods are increasingly employed. In 1923 the American Obstetrical Society subsidized a research group under the direction of Dr.

[1] Mary Ware Dennett of New York City in 1918 wrote a pamphlet entitled *The Sex Side of Life*, for the instruction of her own adolescent boys, a serious, scientific presentation of essential facts which has been widely used by parents and educational agencies. In 1929 she was tried before a Brooklyn Federal Court and convicted of "sending obscene matter through the mails," an offence carrying a possible penalty of $10,000 fine or 5 years' prison sentence or both. The verdict was subsequently reversed by the United States Circuit Court of Appeals.

[2] The American Birth Control League, 152 Madison Avenue, New York City, is the organization which initiated and conducted the propaganda which has resulted in the increasing modification of the state statutes. It is now presenting a bill to Congress designed to modify the Federal law. The American Birth Control League conducts birth-control clinics in cities in most if not all states in which this is legal.

Robert Latou Dickinson which was named "The Committee on Maternal Health," recently incorporated as "The National Committee on Maternal Health." For 10 years this committee has studied and investigated both the medical and social aspects of the subject, and has brought out a number of publications.[1] The work of this committee is furnishing really scientific stabilization of the subject. At the White House Conference on Child Health and Protection (November, 1930) the Committee on Obstetrical Education went on record as believing that contraceptive methods should be taught in medical schools,[2] a thing that could not be done until there was a body of standardized medical information such as the above committee has now made available.

Contraceptive methods must prevent the meeting and union, or prevent the survival of, sperm and ovum. To do this without injury to the delicate structures involved is a difficult problem. Both mechanical and chemical methods may set up injurious irritation, paving the way for infection. It is well known that continuous slight irritation of any tissue predisposes to cancerous growth in later life. The selection of a contraceptive procedure becomes a matter of serious importance to the individual. Especially should the thinly disguised advertisements of "personal antiseptics" which are now appearing in the public press be ignored. Some of the antiseptic solutions so advertised are powerful and irritating and entirely unsuited to this purpose.

Confidential information from a physician of the very highest standing is the only safe method to be pursued at the present time.

[1] The offices of this committee are located in the New York Academy of Medicine, 2 East 103d Street, New York City.

[2] *Obstetric Education*, p. 47, D. Appleton-Century Company, 1932.

CHAPTER IX

LOVE, COURTSHIP, MARRIAGE

Then Almitra spoke again and said, and what of Marriage, master?
And he answered saying:
You were born together, and together you shall be forevermore.
You shall be together when the white wings of death scatter your days.
Aye, you shall be together even in the silent memory of God.
But let there be spaces in your togetherness,
And let the winds of the heavens dance between you.

Love one another, but make not a bond of love:
Let it rather be a moving sea between the shores of your souls.
Fill each other's cup but drink not from one cup.
Give one another of your bread but eat not from the same loaf.
Sing and dance together and be joyous, but let each one of you be alone,
Even as the strings of a lute are alone though they quiver with the same music.

Give your hearts, but not into each other's keeping.
For only the hand of Life can contain your hearts.
And stand together yet not too near together;
For the pillars of the temple stand apart,
And the oak tree and the cypress grow not in each other's shadow.

KAHLIL GIBRAN.[1]

About the primitive necessity of sex mating has developed the superorganization of civilization. The interests of parents and progeny became the interests of the clan, the state, the nation. There is now an International Children's Charter, and within the League of Nations are various secretariats concerned with the standardization throughout the world of protection of the family as an institution, and of the child as an individual.

The sharing of cumulative social experience has brought increased certainty of food, shelter, and safety; increased security and increased leisure time have brought rapid development of science, art, and culture.

In spite of wars and cataclysms the individual was never so free and never so safe as now. The emancipation of women is

[1] Reprinted from *The Prophet* by permission of and special arrangement with Alfred A. Knopf, authorized publishers.

probably the critical episode in the history of individual freedom. The development of science is removing the subject of sex and reproduction from the realm of sacrosanct mystery and superstition, and is making of it a phenomenon of the same order as any other fact of nature. It is probable that the historian of the future will designate the present period as the era of emergence from sex witchcraft with all of its past and passing horrors of ignorance, superstition, cruelty, and suffering.

Correct perspective is difficult or impossible while an active social change is taking place. There are ever two points of view: that of the past or passing generation and that of the present or coming generation. As applied to the situation under discussion we need to remind ourselves that we, in this country, are only two or three generations removed from the pioneer stockade with its high, tight walls and narrowly circumscribed space, outside of which lurked many dangers, both known and imaginary.

Society, at this level, lived also in the midst of terror, real and imaginary, of the unrestrained relationship of the sexes. Not knowing exactly where danger lay, and being acutely conscious of the tremendous import of sex in human life, our forefathers built a rigid stockade of social convention, sanctity of marriage, divorce taboo, and parental authority, inside of which flourished the sturdy family life of the period. Danger of a very real sort awaited the excursion of the individual, especially the woman, from the circumscribed path of conventional conduct. We must not forget that the people of earlier times were helpless before the great unknown wilderness of human passions and mystical and mysterious emotions and impulses. The strongest sanctions of religion and of fear were thrown about the social code and were necessary; there is no doubt that humanity owes its very survival to the rigidity with which these sanctions were applied to conduct.

Now as individuals we are free to explore the world in relative safety. Walls and fences no longer protect our towns and homes. In some communities we do not even lock our doors. We take our vacations camping, gypsy fashion, by the side of the traveled road. Likewise, the sexes now mingle and associate in a freedom terrifying to one of the stockade era of personal virtue. It is

difficult for one who ever lived in dependence upon the protection of restraints, material or moral, to feel quite safe or at ease in open, untrammeled space or freedom.

On the other hand, the free young woman of today, who has never felt the terror of the unknown danger, nor realized the safety which may lie in social restraint, feels "cribbed, cabined, and confined" by boundaries and conventions. She is not conspiring with her generation to overthrow the mores of the past—she is merely living in a new and different world in the only manner in which she can live. She says quite sincerely, "What's there to be afraid of?" and she keeps her mother and especially her grandmother in a semipanic of fear and apprehension.

With the scientific laying of the ghosts of sex superstitions, the shifting of the economic burden to two parental shoulders instead of one, and the rise of the individualism of women, a good deal of the former illusion as to the sanctity of marriage has vanished in the thin air of modern realism. The members of the younger generation no longer believe that "marriages are made in Heaven," and they no longer feel so perfectly certain that they are going to "live happily ever after." This does not mean that they are less serious than their elders, or less in love with each other; for the most part it means only that they are less fear-ridden and a good deal more sure of themselves. They are more poised and more casual because they are better informed and better prepared than any preceding generation.

The marked increase in divorce is merely an index of the social fluidity of the hour. It is a sign that the men and women of the new generation are unwilling to continue a matrimonial situation which has become unsatisfying and intolerable. There seems to be a growing conviction that it is not the divorce but the marriage which is at fault. "If marriages are not made in Heaven we must find a better way of making them upon earth, since marry we must." At present there is no "best way." We have in America and the District of Columbia 49 different marriage laws. A marriage or a divorce may be valid in one state and void in an adjacent state. There is a good deal of current discussion of "the marriage mess." One of the critical present needs is standardized and modernized regulation of marriage. There must first be a general social consensus of

opinion as to what is necessary and desirable, as no law can function beyond public opinion.

With the regulation of marriage divorce will take care of itself. It is unlikely that divorce will ever be made more difficult than it is now. By a curious paradox human beings seem to be seeking increasing individualism within the most drastic solidarity of social organization the world has ever seen. People are thinking together but standing apart, and are agreeing in nothing more intensely and significantly than in the "apartness." Kahlil Gibran has expressed this with mystical spirituality in the poem on "Children" at the first of this volume and in the poem on "Marriage" at the head of this chapter. Probably the most vital flaw in the marriage relationship, and the flaw leading most frequently to the divorce court, is the lack of thoroughgoing conjugal respect for personality.

Ibsen in *A Doll's House* is thoroughly modern in his dramatic picturing of the way in which a married pair may be romantically and intensely in love with each other and still mortally wound one another. The bewildered young husband, Helmer, has conscientiously tried to enforce the domestic mores of his day upon his pretty plaything of a wife who most unexpectedly "becomes a woman."

Helmer—To forsake your home, your husband, and your children! And you don't consider what the world will say.

Nora—I can pay no heed to that. I only know that I must do it.

Helmer—This is monstrous! Can you forsake your holiest duties in this way?

Nora—What do you consider my holiest duties?

Helmer—Do I need to tell you that? Your duties to your husband and your children.

Nora—I have other duties equally sacred.

Helmer—Impossible! What duties do you mean?

Nora—My duties towards myself.

Helmer—Before all else you are a wife and a mother.

Nora—That I no longer believe. I believe that before all else I am a human being, just as much as you are—or at least that I should try to become one. I know that most people agree with you, Torvald, and that they say so in books. But henceforth I can't be satisfied with what most people say, and what is in books. I must think things out for myself, and try to get clear about them.

Helmer—Are you not clear about your place in your own home? Have you not an infallible guide in questions like these? Have you not religion?

Nora—Oh, Torvald, I don't really know what religion is.

Helmer—What do you mean?

Nora—I know nothing but what Pastor Hansen told me when I was confirmed. He explained that religion was this and that. When I get away from all this and stand alone, I will look into that matter too. I will see whether what he taught me is right, or, at any rate, whether it is right for me.

Helmer—Oh, this is unheard of! And from so young a woman! But if religion cannot keep you right, let me appeal to your conscience—for I suppose you have some moral feeling? Or, answer me: perhaps you have none?

Nora—Well, Torvald, it's not easy to say. I really don't know—I am all at sea about these things. I only know that I think quite differently from you about them.[1]

At the moment the entire world is openly sex-conscious because the mass of people are more aware of the new freedom than they are of the new dignity of the subject. It will take more than one generation to achieve general clean-mindedness and casual-mindedness toward the relationship of the sexes. Spots in the muddle are clearing up, however, and the miasmas will spend themselves. Romantic love seems fair to continue to be (with parental love) the strongest emotional bond in human life, but it is no longer held to be the only basis for marriage. The rosy glamour of early passion fades and is succeeded by long days and years of daily companionship in which mutual interest and congeniality are essential to happiness.

Love is in one respect like food: it matters most when one hasn't any. This is the situation of many unfortunates in this world of ours. There are more people starving for love and affection than for food, and their situation is intensified and embittered by the general attitude to marriage. Love and sex are by no means identical; yet the inner life of civilization is at present dominated by an unintentional conspiracy which has for its apparent object an exaggeration of the importance of sex. The means employed are so diabolically ingenious that, if one did not know that the situation had merely happened, one would of necessity

[1] Ibsen, Henrik, *The Collected Works of Henrik Ibsen*, vol. 7, *A Doll's House*, pp. 147–149, Charles Scribner's Sons, 1927.

suspect craft and intention. Our whole prose literature, essays and fiction, is given over to discussion and depiction of "romance." The average novel describes the events which lead up to marriage; novels of married life describe the events which lead up to divorce and remarriage. This is one outstanding influence brought to bear upon youth. It finds as complement an even more nefarious compulsion, the general suppression of competent sex discussion. For adequate sex discussion is substituted the pornographic novel or instruction in false psychologies. What wonder that sex writes itself into our newspapers and fills hospitals, asylums, and prisons! A continuous positive stimulation coupled with a direct and negative suppression does not recommend itself as a method of helping the young to see sex and marriage with clear eyes.

The situation is especially difficult for the man or woman who is alone, or virtually alone, as many are, in a big city. Everywhere such a person finds suggestion and suppression. If he, or she, goes to the "pictures" he is first assured that the picture has been "passed" by the censor of public morals. Having received this assurance, he is compelled to watch a wearisome series of anticlimaxes—husbands, wives, and lovers posing and posturing about the eternal triangle. Like a new Euclid, the moving pictures are an attempt to infer, by abstract reasoning, all the properties of triangles. There is much to be said for a love story which is simple and fine; it is an incentive and inspiration to youth. But overemphasis and exaggeration of the importance of sex is bad, even if it is not directly vicious. It does not make life easier for those who desire love without opportunity of realization.

In the primitive marriage sex is probably the dominant factor. Civilized marriage is quite otherwise; it includes sexual intimacy, of course, but only as a relatively small item in a highly complex situation. The sex factor may seem important at first but is soon merged in wider interest—intellectual and social copartnership, children, a house and garden, a joint career, children's careers, friends held in common. Sex, as developed by civilization, is very complex.[1]

We may summarize the factors of successful marriage somewhat as follows:

1. Disciplined character. A selfish, self-centered person who does not respect the personality and rights of others will wreck marriage as well as every other relationship of life. It must be remembered, however, that "reconditioning" is possible,

[1] Mayo, Elton, Should Marriage Be Monotonous? *Harper's Magazine,* September, 1925.

even in adulthood, and that a deep affection is one of the best agents for accomplishing this. There is an element of chance in every marriage, and adaptations are necessary between any two personalities.

2. Love and affection. It requires a deep and mystical conviction that "they are made for each other" to enable a man and woman to come safely and painlessly through the adjustments to the restrictions and intimacies of married life.[1] One writer to the newly married says, "You may always *love* each other but there will be times when you will not *like* each other!" The bond of true affection is the anchor of safety in every time of domestic stress and storm.[2]

3. The factor of comradeship, of enjoyment in each other's presence, community of tastes, liking at least many of the same things, is even more fundamental to continued harmony and happiness than is romantic attachment. Sheer boredom has wrecked the happiness of many homes. Harmony also involves agreement as to beliefs and issues which seem important to one or both of the married pair. If one considers a certain religious belief to be the one and only true doctrine of salvation, it is inviting disaster to marry an individual who does not and cannot believe that way. Every couple contemplating marriage should know each other well enough and for long enough to be certain that they will not "get on each other's nerves," that they will find rest and repose in each other's presence, and that they agree, or are certain of being able to make adjustments, in regard to tastes, beliefs, personal habits and practices, and all the matters which are involved in the intimacies of daily life. In order to be able to agree about mutual interests there must not be too much disparity in age and education.

4. Harmony in sex life. Certainly every engaged couple should talk frankly about sex life after marriage and be as certain

[1] "(The) quality of deep, enduring love should be assiduously sought after in selecting a mate. Without this love there should be no marriage. . . . Eugenics is making sure that one is worthy of being loved. Eugenics ascertains, as far as possible, beforehand that there are qualities making for the permanence and increase of love." Ralph E. Danforth, Family and Conjugal Affection as a Factor in Human Evolution, *Scientific Monthly*, January, 1929.

[2] Dell, Floyd, *Love in a Machine Age*, Farrar & Rinehart, Inc., 1930.

as possible that they agree as to the marital relation, having children, and rearing children. One of the salutary features of the new sex freedom is that the young woman no longer opens the door to married life in appalling ignorance of the experiences awaiting her. One of the vital problems confronting the young of today, however, is that of determining what is rational sex life for the married as well as for the unmarried. Here, unfortunately, there is little in scientific or social literature to guide them. There is some effort at present to bring the marriage experience under scientific understanding.[1] The work of Katharine Bement Davis is outstanding in this field.[2]

The very proper demand of the young for help in forming personal codes of sex conduct is bringing out a flood of books on how to achieve happy marriage. Most of these are worthless and some are vicious. The young person should beware of books which present dogmatic formulas for securing sex harmony or which seem to present definite conclusions or rules for marital conduct. At the present time there are no conclusive data for formulating dogmatic rules.

Courtship.—The adolescent boy and girl think of marriage and are keenly and legitimately interested in meeting and identifying the "soul mate." The normal way of bringing this about is through happy, hospitable home life. Boys and girls who fight each other in the grades, and date with each other in high school, and who run freely in and out of each other's homes, come to know each other and "like each other" as well as fall in love with each other. Such matings may lack some of the glamour and violence which attach to "love at first sight," but they are apt to be more comfortable and enduring.

Unfortunately all young people cannot know each other in this familiar and casual way. Our present changing social order is highly deficient in mechanisms for bringing the sexes together naturally and freely enough to permit of variety of selection and choice, and especially to permit thorough acquaintance.

[1] KEYSERLING, COUNT HERMAN, and OTHERS, *The Book of Marriage*, Harcourt, Brace & Company, 1925.

[2] DAVIS, KATHARINE BEMENT, *Factors in the Sex Life of Twenty-two Hundred Women*, Harper & Brothers, 1929.

It is natural to put the best foot foremost in courtship. Every man and every woman should, however, value future married happiness too much consciously to practice deceit in courtship. As many adjustments should be made before marriage as possible, and the engagement should be long enough to insure thorough acquaintance and familiarity with each other's habits and attitudes in various typical situations.

Liberties with the Person (*"Petting"*).—The changed attitude toward sex and marriage has precipitated a freedom of personal relationship between the sexes in general which rather takes the breath of the oldster! Since the adult, having been brought up under quite a different code of conduct, cannot be a proper judge, and since he cannot intrude, and hence may "guess" more than he "knows" as to said conduct of the young—it is perhaps seemly for the writer (herself an "oldster") to touch lightly upon the subject of "petting." She believes the present generation of fine, sincere young people can be trusted to work this out as well as the many other problems the older generation has passed along to them. Here, as in marriage, respect for personality, one's own and the other, should come first. The young should also realize the physiological importance of glandular function. They should be prepared for the overwhelming experience of the maturing of the sex hormones. It is the crime of the elders that the young are still so largely kept in ignorance of their own bodies, and at the same time are subject, as Elton says, to constant psychic stimulation. This is no place to preach—it is the place to share knowledge and experience. *Physical contact arouses the sex glands and may lead literally to overpowering chemical intoxication,* with consequent indiscretions in conduct. One of the present responsibilities of scientific-minded young college men and women is the determination of a safe and sane code of conduct for the human mating young which shall replace the old code of chaperonage and restraint.

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CHAPTER X

PREGNANCY

Seeing you round and full with ripening fruit of your body, in the sweet old way, the brave old way of women, I must sing and leap, and shout,—and I must kneel and pray, knowing you more than woman in this day of new creation, in this flowering spring of human fruitfulness. The gift you bring mocks the iron centuries that blast and slay.

You are the Race, you are the seeded Earth, you are the Torch that carries on the flame, and you are God made woman for a space. Now, as that inward glory lights your face, I, man, abase myself before your name and envy you the power of giving birth.—Clifford Gessler.[1]

Ovulation.—Definite research is obviously difficult in matters relating to the functioning of human reproductive organs. It seems probable that only one ovum matures or ripens and escapes from an ovary during each menstrual interval. This is called *ovulation*. It is not known whether the ovaries alternate in this or not. It is known that a woman with only one, or even only a part of one ovary, may menstruate regularly and produce a normal number of children. The ovum ordinarily finds its way into the fimbriated extremity of the nearest Fallopian tube; here it is propelled along by the cilia which line the tube, until, in the course of a number of days, variously estimated at from 3 to 7, it reaches the uterus.[2] The surface of the ovum is covered with adherent follicular cells (see Fig. 8). These are loose in attachment and do not interfere with the entrance of the sperm into the egg.

[1] Courtesy *Birth Control Review.*

[2] Extrauterine pregnancy or "ectopic gestation" may occur. Occasionally the fertilized ovum lodges in the Fallopian tube and never reaches the uterus. This is called *tubal pregnancy.* The ovum goes as far as it can in its development under its restricted conditions but never goes to full term. Sometimes it becomes a tumor-like mass and is removed surgically. Once in a very long time fertilization occurs in the fimbriated extremity of the tube or in the abdominal cavity. This is called *abdominal pregnancy* and also requires surgical removal.

Fertilization or Conception.—The normal and usual place for the meeting of the male and female cells is in the Fallopian tube. If sexual intercourse has occurred within a period of several days, live spermatozoa will be found in the vagina, the uterus, and even in the tubes. Apparently a strong hormone attraction leads the spermatozoa to swim upstream, so to speak. When one of these meets an ovum and touches it the nuclei of the two are powerfully attracted to each other and fusion occurs. At the instant the head of the sperm enters the ovum the character of the surface of the entire cell becomes so altered that probably no other spermatozoon may penetrate the ovum. At least only one unites with the nucleus (Fig. 36). The spermatozoon leaves its tail outside, and shortly there is a new cell with 48 chromosomes which at once begins to divide and subdivide, while the cilia lining the tube continue to propel it along toward the uterus or "nest."

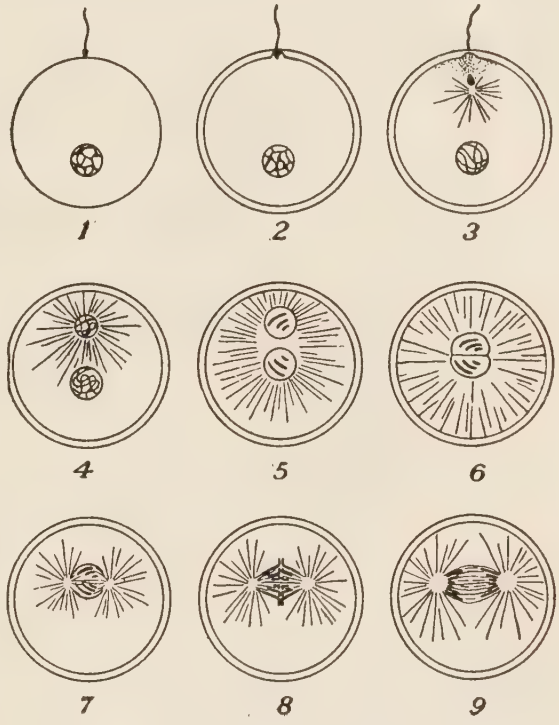


FIG. 36.—Diagram of fertilization. (*After Plunkett, Modern Biology, Henry Holt & Company.*)

Implantation.—By the time the fertilized cell reaches the uterus it has become a mass of cells perhaps as large as the head of a pin, depending upon how long it has been on the way. The uterus is still vascular and soft under the stimulation of the female sex hormone (see page 118). Normally and usually the ovum comes to rest within the triangular space in the body of the uterus.[1] Here it speedily sinks from sight, apparently having

[1] Occasionally the fertilized ovum passes on to the cervix before it stops, and then lodges near or in the cervix. This may not be discovered until the time of birth, when the placenta is pushed ahead of the child instead of coming after, a condition known as *placenta previa* (the placenta coming before). It will usually be detected by the physician during pregnancy, and he will know how to manage the complication when the child is born.

some digestive or enzyme action upon the uterine membrane (Fig. 37).

The Membrane. *The Amnion.*—Cell division goes on rapidly and soon the ovum presents the appearance of a delicate, transparent capsule inside of which on the side of contact with the uterus appears a cell mass which is proceeding to develop into the embryonic child. This capsule is the first of the two mem-

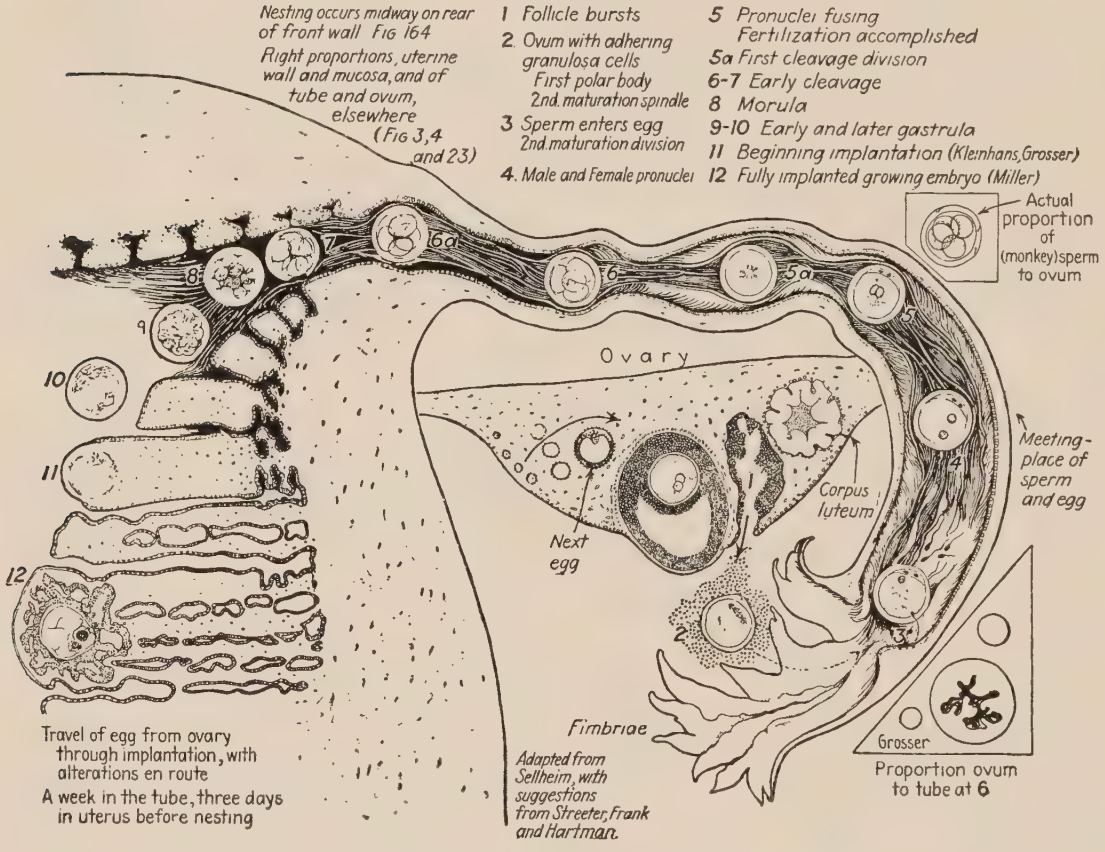


Fig. 37.—Journey of the ovum from the ovary to its implantation in the wall of the uterus. (*Dickinson-Elwyn, after Sellheim.*)

branes with which the embryo surrounds itself. It is filled with fluid and is called the *amniotic sac* or "bag of waters." The fluid, known as the *amniotic fluid*, is highly protective in that it equalizes pressure upon the embryo and permits it to have a maximum freedom of movement. It is said that the fetus swallows amniotic fluid during the later weeks of intrauterine life. Whether it does so accidentally or whether it thus obtains needed water and nutriment is not known.

The Chorion.—Very soon the amnion is surrounded by the second embryonic layer, which is known as the *chorion.* This is rough and shaggy and covered with villi or fringe-like projections.

When the chorionic coat is pulled apart from the decidua and floated out in water it resembles a chestnut burr. On the side of contact with the uterus these projections sink like rootlets into the vascular uterine wall. As time goes on these become more branching and root-like while the external surface becomes more smooth.

The Decidua.—When the cell mass sinks into the lining of the uterus the lining folds over it in such a way that eventually the

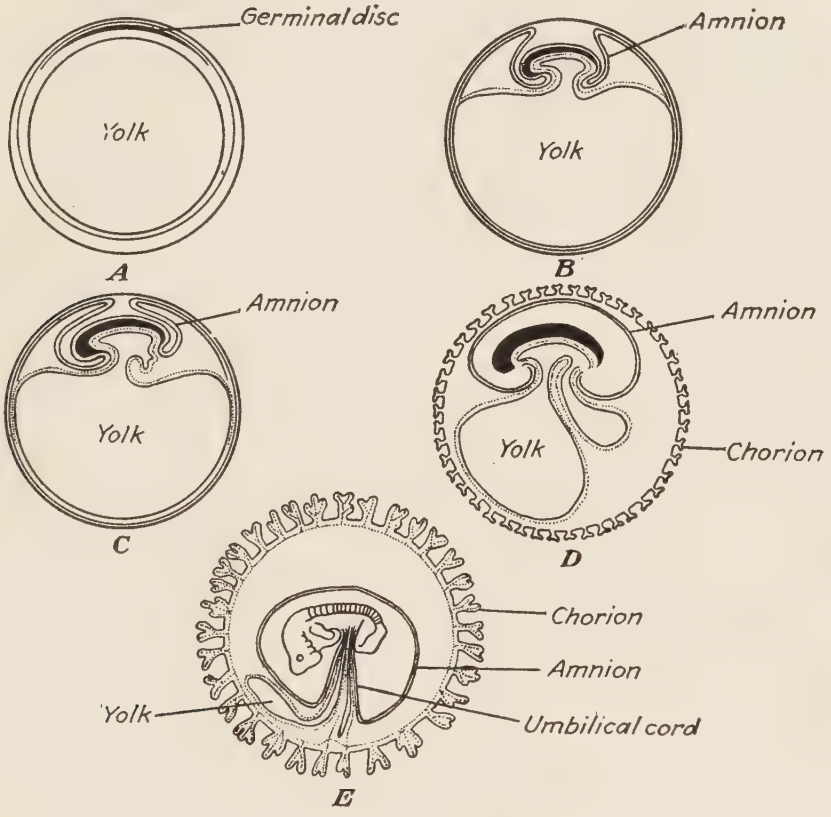


FIG. 38.—Stages in the development of the fetal membranes and cord. (*Modified from Edgar, The Practice of Obstetrics, P. Blakiston's Son & Co.*)

chorionic coat is covered with *two layers of uterine membrane* which are called the *decidua*. The chorion closely interlocks with the inner decidual layer (Fig. 38).

The Cord and Blood Vessels.—On the side of attachment to the uterus the chorion develops within the villi, or rootlets, a mass of branching blood vessels which are attached to the body of the child by means of the umbilical cord (Fig. 39). The cord may become 10 to 20 inches in length. The cord is the thickness of a man's finger and conveys the three placental blood vessels, a vein carrying pure blood passively back to the fetus and two

arteries carrying impure blood from the fetal body to the placenta. It has no nerve connection whatever with mother or child. This network of blood vessels ramifies through the villi of the chorion which have penetrated the vascular lining of the uterus and divides into capillaries which come to lie side by side with the capillaries of the decidua and sometimes lie in small "blood lakes." *There is never any direct union of fetal and maternal blood vessels; exchange of nutritive and waste material is accomplished by filtration or osmosis between these two sets of capillaries.* The capillaries join to form the veins which carry the pure blood back to the body of the fetus (Fig. 40).

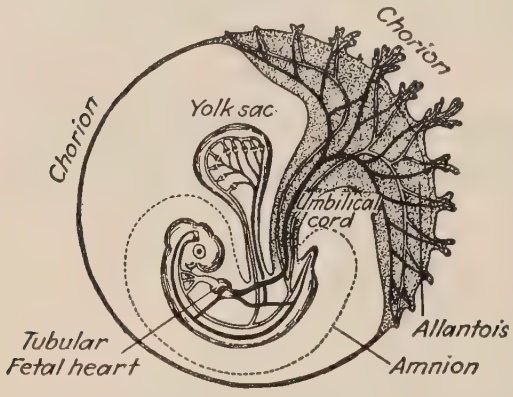


FIG. 39.—Diagram of placental circulation. (*Modified from Wilder, History of the Human Body, Henry Holt & Company.*)

The Placenta or "Afterbirth."—These four membranes, two formed by the embryo and two by the uterus, form a sac about the embryo, very thick and full of blood vessels on the side which is attached to the uterus, and relatively thin on the other side. This entire structure is called the *placenta* or sometimes the *placenta and membranes.* The portion which is attached is, at the time of maximum size, circular, about 8 or 9 inches in diameter, thin about the edges and about an inch thick in the center where the cord is attached (Fig. 41). While these structures are forming the fetus has developed its own heart and circulatory system, which is continuous with the placental circulatory system just described, and eventually its heart begins to beat and forces the pure blood received through the one umbilical vein from the placenta throughout its own body, and forces its used blood out to the placenta through the two umbilical arteries. The fetal heart beats almost twice as fast as that of the mother. The scheme of fetal circulation may be said to resemble a "figure eight" in which the large loop is in the child's body, the small in the placenta, while the cross is within the cord. More exactly, perhaps, the circulation within the body of the fetus may be likened to that of the sap in the branches and leaves of a tree;

the trunk would represent the cord, while the roots of the tree would represent the placental blood vessels imbedded within the nourishing soil of the uterine wall. In this way the human parasite feeds upon the bounty of the maternal hostess much as



Fig. 40.—The blood vessels in the placenta—one vein and two arteries with their intermediate capillaries. The capillaries ramify through the chorion. The vein and arteries carry the blood through the cord.

a fungus feeds upon a tree, or a plant draws sustenance from the moist warm earth through its branching rootlets.

Nutrition of the Embryo.—Small as is the human egg, provision is made for the nutrition of the tiny embryo until it becomes attached to the uterine wall by a small amount of yolk which is used up by the time the placental circulation is established (see Fig. 38). The ovum also absorbs some nutritive substance

and much water directly from the wall of the uterus in which it becomes imbedded. From the time the embryonic heart begins to beat the child becomes entirely dependent upon his mother's bounty.

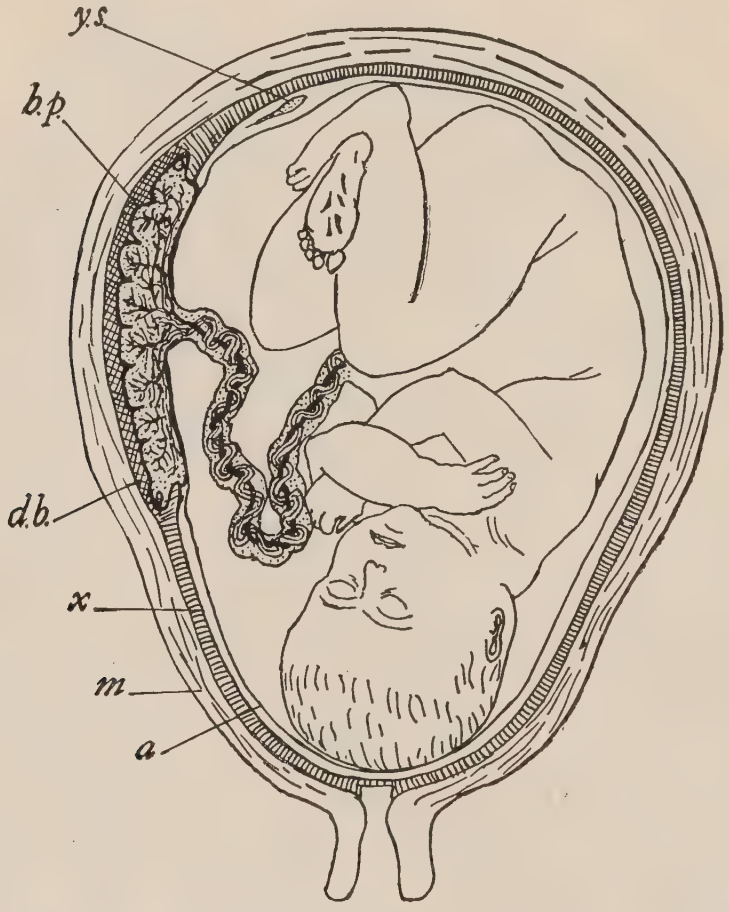


Fig. 41.—Diagram of uterus near end of pregnancy showing placenta, membranes, and cord. (*After Wieman, An Introduction to Vertebrate Embryology.*)

Stages of Development.—During the early weeks of pregnancy the developing child is usually spoken of as the *embryo;* later it is called the *fetus.*

Four Weeks.—Although the embryo doubles its size rapidly it started from such a very small beginning that at the end of 4 weeks it is only ¼ inch long. The entire sac of amniotic and chorionic membranes is about the size of a pigeon's egg. Even at this stage the rudimentary beginnings of the various organs are discernible, including the thymus and thyroid glands. The limb buds can be seen, which at first are fin-like in character, and the branchial grooves strongly suggest gill slits.

Eight Weeks.—By the end of the eighth week centers of bone growth begin to appear, the limbs are further developed, and webbed fingers and toes are seen. The caudal appendage or tail is noticeable and the embryo is about 1 inch long.

Twelve to Sixteen Weeks.—Between the third and fourth months the sex organs become differentiated. Up to this time it is impossible to tell whether the child will be a boy or a girl. The villi have largely disappeared from the chorionic membrane except at the place of attachment, where they have entered into the formation of the placenta. The teeth are forming and the fetus begins to move actively. By the end of the fourth month the uterus has moved up into the abdomen and the fetal heart beats can be heard through a stethoscope. About this time the body becomes covered with fine hair or fur called *lanugo* which disappears at about the seventh month. A tar-like substance called *meconium* appears in the intestines. The placenta is larger and the cord is longer and larger.

Twenty Weeks.—During the fifth month hair appears upon the head, the finger nails are beginning to form and the fetus is about 10 inches long and weighs about 9 or 10 ounces.

Twenty-eight Weeks.—At seven months the fetus may live if born prematurely but must receive very precise care. It then measures about 14 or 15 inches long and weighs approximately 2½ or 3 pounds. This is called in vital statistics and legal codes *the age of viability.*

Forty Weeks.—At 40 weeks (10 lunar or 9 calendar months) or, as some authorities now believe, 10 menstrual periods of the woman concerned, the child has reached full intrauterine development, or "full term," and birth occurs. The average child will measure about 20 inches when born and weigh about 7 to 7½ pounds. Boys tend to be slightly larger than girls.

Signs of Pregnancy. *Probable Signs.*—It is sometimes a difficult matter to diagnose early pregnancy and even good physicians are occasionally mistaken. Usually, however, the following signs are present and may be taken to mean that pregnancy has probably occurred:

1. Stopping of the period of menses. In a healthy woman who usually menstruates regularly this is a strong indication that

pregnancy exists. There may be other reasons for the temporary suppression of the menstrual periods.

2. Morning sickness. A sense of nausea or even vomiting when the stomach is empty or after the first food is taken in the morning, when the digestion and health do not seem otherwise disturbed, is an experience common to from one-third to one-half of all pregnancies. When it appears along with the stopping of menstruation it is fairly conclusive evidence.

3. Enlargement of the breast and darkening of the ring about the nipple. These changes usually appear along with the previous two signs and lend strength to the probability of pregnancy. It must be remembered, however, that a tumor in the uterus or other disorders of health sometimes produce all these symptoms, and that once in a long time all may occur without pregnancy. Sometimes, during pregnancy, the breasts may even excrete a small amount of fluid.

4. Visible enlargement of the abdomen is also one of the probable signs. It occurs at very different times and in different degrees in different women, depending upon posture, size of fetus, and amount of amniotic fluid, so that it indicates little or nothing as to duration of pregnancy.

5. Frequent urination is often present because the heavy uterus rests against the urinary bladder and prevents its usual expansion, also because of congestion and irritability in the urethral tract.

6. Constipation. Pressure of the uterus upon the rectum may, for a time, make defecation difficult.

7. The gait of pregnancy. A woman walks differently during the later stages of pregnancy, leaning slightly backward and balancing herself with care because of the displacement of the center of gravity. This characteristic gait is sometimes called "the pride of pregnancy."

Positive Signs.—1. Quickening or feeling life. About midway in pregnancy, or at 4½ months, the pregnant woman usually begins to feel the fetus move. The contents of the abdomen are always in motion, however, and the muscles of the uterus contract in health. If a woman is a little nervous or strained over the matter it is easy for her to think that a bubble of gas in the intestine is the movement of the child. Every now and then a

woman who is not pregnant, and who has never been pregnant before and therefore does not know the sensation from experience, tells her doctor she is sure she has felt life.

2. Feeling the fetus move when the physician or other person lays hands on the abdomen and actually feels and sees the child move, may be considered as positive.

3. Feeling parts of the body. The physician can sometimes make out the head and various parts of the child's body definitely enough to be certain that it is a child and not a tumor.

4. Fetal heartbeat. When the doctor hears the fetal heartbeat at 4 to 5 months there can no longer be any doubt.

5. Laboratory tests. The blood serum or urine of a pregnant woman when injected into experimental mice causes increased growth and activity of the ovaries and uterus (the Ascheim-Zondek test, see page 116). In case of certain diseased conditions, or in some legal situations, early diagnosis is sometimes important. The specific character of the cells found in the vaginal secretions at different stages of the menstrual cycle and during pregnancy is also a help in conclusive diagnosis.

Probable Date of Confinement.—The length of pregnancy varies in different women; it is, therefore, often impossible to compute the exact date of labor. Pregnancy, as indicated above, lasts on an average 9 calendar or 10 lunar months or 273 to 280 days. The usual method of estimating the date of confinement is as follows: Count back 3 calendar months from the first day of last menstruation and add 7 days. For example, if the first day of the last menstruation was Oct. 10, counting back 3 months would give July 10. Seven days added would give July 17 as the probable date of confinement. The English method of computing date of confinement may be preferred, *viz.*, add 40 weeks or 280 days to the first day of the last menstruation.

There is some evidence that the normal duration of pregnancy is 10 menstrual periods. Thus, a woman menstruating every 26 days would expect her child to be born after about 260 days gestation. Since spermatozoa may live for an indefinite time in the female tract and since it is impossible to know the exact date of ovulation it is difficult to be precise in computation, for the date of coitus (sexual intercourse) and conception (fertilization) may not coincide (see page 130).

Maternal Impressions.—From the facts which have been given regarding the development of the embryo and fetus, it is very plain that no mother can "mark" her child. The mother's mental and nervous condition will have no effect whatever upon her child unless through anger, fright, worry, or shock she injures her own health and poisons her own blood and thus makes it impossible for her to nourish her baby properly. Definite reasons are now known for most such congenital defects as were formerly thought to have been caused by some experience of the mother.

Prenatal Amputations.—Sometimes a child is born with part or all of a hand or foot lacking. This may be caused by the cord becoming wrapped about the wrist or ankle and shutting off the circulation.

Hairlip and cleft palate are caused by failure of the two halves of the face to unite fully. This is because the bones develop from centers of growth, and many of the flat bones of the skull and face are not fully changed from cartilage to bone at the time of birth. In the case of the bones of the jaw, however, development and union cannot be completed after birth, and the deformity must be corrected by surgical operation.

Colored birthmarks are caused by deposits of pigment or coloring matter similar to the pigment in the hair and eyes. No one knows just why this happens. No one yet knows much about the way pigment develops and is distributed so carefully to eyes and hair. It is not so very remarkable that occasionally some of it should be misplaced. The resemblance of these colored patches to known objects is pure accident. Much more often these patches resemble nothing whatever. A spot of ink on the floor is just as apt to resemble some object.

Monstrosities may result from endocrine disorder in the mother or in the fetus. Syphilis and chemical poisons may injure the germ cell in such a way that an imperfectly developed child results.

Every pregnant woman should be quite easy in her mind concerning this subject. She should, however, exercise self-control and not give way to anger or fright because of the effect upon her own health and thus indirectly upon the nutrition of her child.

Maternal Changes.—The average, normal woman increases in total weight during pregnancy because of the added weight of the fetus with the placenta and fluids. She also usually increases somewhat in body weight because her metabolic processes are more active. She digests food more readily and has an increased appetite. The total increase in weight varies greatly, but is usually 20 to 30 pounds.

The abdomen and breasts enlarge, the center of gravity shifts, and during the later months of pregnancy a woman walks with characteristic precision and care; she throws her shoulders back to compensate for the heavy abdomen.

The sutures or lines of union between the bones of the pelvis soften slightly during later pregnancy, thus allowing a slight but important shift in diameters at the time of labor.

The pigment distribution in the skin is affected by pregnancy. The dark areola about the nipple becomes darker. As the abdomen becomes distended streaks or striae appear which sometimes remain as white scars after the birth of the child.

Sometimes irregular patches of dark pigment appear upon the face, and now and then upon the body. These almost invariably disappear after the child is born, sometimes before.

The uterus increases in weight from 2 ounces to 2 pounds at full term. Within 4 to 6 weeks following the birth of the child, it returns again to its original size and shape (involution).

The vaginal tract usually shows an increase of mucous secretion because of the generally increased physiological activity. The vaginal secretions are antiseptic in character. No douches or internal treatments should be taken except under advice of a physician.

The sweat glands and oil glands of the skin share in the general physiological speeding-up and tend to increased secretion.

The endocrine glands are also increasingly active during pregnancy. When they are perfectly adjusted the effect is a sense of increased vigor and exhilaration. When they are not perfectly balanced a variety of nervous and mental symptoms may result, especially if complicated, as so often happens, with the loss of strength through faulty diet and deficient sleep and rest.

The metabolism in normal pregnancy shows certain significant changes in that both nitrogen (protein) and minerals are stored

in excess of the daily need. This is an important reserve for the approaching demands of labor and lactation.

In general, a pregnant woman who is normal and follows a hygienic program should expect to feel well and more than usually vigorous and buoyant during most of her pregnancy. If she falls short of this she and her physician should make every effort to discover the reason and correct it.

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CHAPTER XI

THE HYGIENE OF PREGNANCY

Where the city of the faithfulest friends stands,
Where the city of the cleanliness of the sexes stands,
Where the city of the healthiest fathers stands,
Where the city of the best bodied mothers stands,
There the great city stands.

WALT WHITMAN.[1]

I. PROFESSIONAL CARE

The best protection a woman can have during pregnancy and childbirth is good care from a physician. Next to this comes intelligent personal care from a nurse and good help in her home.

The Children's Bureau of the U. S. Department of Labor has made many investigations and after interviewing thousands of mothers and consulting outstanding obstetrical authorities certain standards of professional care have been formulated as being necessary for the protection of the life and health of mothers and babies. These standards were set forth in the early bulletin issued by the Bureau called *Prenatal Care*. Similar standards have recently been confirmed by the Section on Medical Care of the White House Conference. In general all authorities now agree that every pregnant woman should receive the following attention from her physician. She should demand this care and should be willing, if financially able, to pay a fair price for it.

Early Consultation.—The best physician available should be consulted as soon as the fact of pregnancy becomes known, otherwise he cannot be expected to prevent complications. Indeed, both parents should have had medical and health examinations before marriage.

Standard Physical Examinations.—The physician should make a standard physical examination including family and personal history of both parents, a thorough examination of heart and

[1] "Song of the Broad-Axe," from *Leaves of Grass*, reprinted by permission of Doubleday, Doran & Company, Inc., Publishers.

lungs, abdomen and pelvic organs, and all laboratory tests which may be indicated.

Pelvic Measurements.—If this is the first pregnancy he should make pelvic measurements to discover whether or not the diameters of the birth canal are normal.

Urinalysis and Blood Pressure.—Once a month the expectant mother should take to her physician 6 ounces of fresh urine in a clean, scalded bottle. From the seventh month on this examination should be made once every 2 weeks. When the urine is taken to the physician he should take the blood pressure. The reasons for this are discussed under Complications, page 222.

Hygiene.—The physician will give advice as to diet, exercise, and other health habits, will insist upon dental care, and will usually suggest helpful and instructive literature.

Home or Hospital.—Every expectant mother must decide early whether she will be confined at home or go to a hospital. In towns or cities where good obstetrical hospital service is available obstetricians are apt to advise and even require that their patients go to a hospital. This economizes the doctor's time and lessens his responsibility, as the hospital staff will keep him correctly informed of the progress of the case. He is also sure of standardized nursing service with equipment and assistance for meeting emergencies. On the part of the mother and family, going to the hospital makes disruption of household routine unnecessary, and does away with the trouble of making or purchasing supplies and equipment for confinement. On the other hand, the majority of the women of the world, even in our own country, do not have good hospital service conveniently near. If the hospital does not have a special obstetrical service there is more or less hazard from general contagions. The small cottage hospital is apt to be anything but sound-proof, and some women are disturbed by the unavoidable sounds and odors accompanying general surgery and other hospital work.

There is a suggestion of pathology about hospitals which does not harmonize with our declaration that childbirth is, or ought to be, a normal, physiological phenomenon. Every possible care should be taken to prevent pathology or complications, but the normal, uncomplicated case needs only cleanliness, quiet, and proper food; and these can be provided in most homes.

In modern, well-managed obstetrical or "lying-in" hospitals efficient machine-like methods prevail. Both mother and baby are necessarily "Room I" and "Baby I" to nurses who must care for a considerable number of cases at once.

A very common fear in going to a large hospital is that one's baby may be exchanged for another. There is now little danger of "mixing" babies, as every hospital has a method of identification by means of metal name-necklace or bracelet, printed adhesive, or inked footprints similar to identification fingerprints.

Babies usually adapt themselves to the rigid routine and are started upon their habit-training by the time they leave the hospital. Some mothers also fall in with the routine and impersonal character of the service better than others. Some like better to occupy the center of the stage at home and enjoy the special attention of the family and the nurse.

Where there are older children, it is thought by some that they should have the educational experience of having a baby brother or sister born in the home, of course being spared the actual witnessing of the mother's suffering. The question has also been raised whether the father does not miss a rich spiritual experience and a proper vicarious share in the procedure if it takes place entirely out of the range of family contact. It must seem more vividly to be his child if he does "stand by" during the ordeal and have some personal responsibility.

On the whole, the following conclusions may fairly be drawn: (1) Every woman who has any reason to expect a complicated or difficult birth should go to a hospital. (2) Any woman who cannot have intelligent, cleanly care at home or who cannot be made comfortable on account of inadequacies of housing or poverty should go to a hospital. (3) The woman who is healthy and who is enjoying a normal pregnancy may safely follow her own preference as to home or hospital care.

Household Help.—The expectant mother should begin early to plan for withdrawal from the work of the household. The life of the family should be systematized and simplified to the utmost and the various members of the family should be trained each to take certain responsibilities. They should do this early enough to relieve the mother more and more as time goes on. There will

then be no sudden explosion of disorder at the time above all others when order is most necessary.

If it is possible to have hired help, this help should be brought into the home and the routine adjusted in time to relieve the mother both mentally and physically, and give her a chance to gather her mental and physical forces together before the onset of labor.

If it is not possible to have outside help, and the family, grandmother, or neighbor must do all that is done, the mother should reduce the work to the lowest possible terms by putting away things not actually needed and in use, leaving the fewest possible things to clean. Every member of the family should be trained not only to take care of his own things, but to do a little more, and the expectant mother should plan just what each one in the household is to do and just what the grandmother or neighbor is to do. Such plans should be made in advance so that no one will have to run to the mother when she is bed fast and ask where things are and how things are to be done. Even the ordering of food supplies and general plan of the meals may be partially cared for some time in advance.

The Cost.—The rapid advance of medical science has made necessary long expensive training followed by specialization. An increase in medical fees of every kind has accordingly become unavoidable. The situation gives the rich an unfair advantage in health protection. Free clinics, including prenatal and obstetrical clinics, have partly solved the problem for the very poor. Members of the great, self-respecting middle class are getting the worst of it. Young couples on small salaries must budget carefully in order to meet the cost of having and rearing a child.

One young couple conscientiously put by a sum sufficient to meet the expected expense. A serious and unexpected complication of labor made it necessary to call in a noted specialist whose usual fee was $500. He cut this in two, in this case, but even so it took the strictest economy and monthly payments for a year to pay it. After the eleventh month the young father wrote gleefully to his parents: "One more payment and the baby is ours."

It is impossible to make a standard estimate of cost on account of variation in fees, living conditions, etc. A committee has been appointed by the American Medical Association for the purpose

of making an exhaustive study of all kinds of sickness cost, including medical and obstetrical service. The final report of this study should point the way to equalization of both service and cost. The average middle-class family will have to make a budget covering the following items. Unless a special nurse is employed in the hospital there is little difference in cost between home and hospital care of similar adequacy.

If Confined at Hospital	Costs
Service of obstetrician for 10 months, including regular urine analysis and frequent interviews, etc.	$ 50 to $100
Hospital delivery fee	10 to 20
Hospital room and floor nursery (10 to 14 days)	50 to 100
Layette and equipment for babe	25 to 50
Domestic service on return to home (2 to 4 weeks)	20 to 40
Miscellaneous	15 to 40
	$170 to $350

If Confined at Home	Costs
Service of obstetrician	$ 50 to $100
Practical or trained nurse (2 weeks)	40 to 80
Domestic service (4–8 weeks)	40 to 80
Layette, etc	25 to 50
Miscellaneous	15 to 40
	$170 to $350

The cost of maintenance of a child after birth varies, and may involve high pediatric fees and expensive artificial foods, or in the case of the normal, breast-fed infant may be very little. Every infant should either attend a well-baby and preschool clinic regularly or be taken regularly to the family physician or pediatrician. If the latter is the preferred method, or if there is no available health clinic, the pediatric fees must be considered. There is a tendency at present to regard a baby as a luxury. In any event, the cost of having a baby fairly balances the cost of a good victrola or radio and still does not often approach the cost or upkeep of an automobile.

II. DIET

Amount of Food.—The fetus multiplies its original size ($\frac{1}{125}$ inch) rapidly, yet the actual amount of new substance

created in fetus and placenta each day is insignificant until the later months of pregnancy. Nine-tenths of the total gain in fetal weight occurs after the fifth month and one-half during the last 8 weeks.[1]

The question of the optimum amount of food in pregnancy has only recently become a matter of definite research. Still more information is needed to clarify the matter. Recent research seems to indicate that the food needs follow the growth of the fetus, as indicated above, and are measured chiefly by the food requirements of the fetus.

Certain studies by Root and Root[2] show that in the subjects measured the basal metabolism (see Basal Metabolism, pages 645–648, Appendix *A*) increased between the sixth and ninth months to the extent of about what would be required by an organism of the size of the fetus.

This conclusion was further confirmed by Carpenter and Merlin,[3] who took the basal metabolism of a woman near the end of pregnancy and of the same mother and child soon after delivery and found the two results to be approximately the same. Sandiford and Wheeler, Rowe and Alcott, and others, have produced similar evidence.[4]

In the report of the White House Conference we read: "In pregnancy the total energy production increases slightly. Such increases apparently represent the heat production of the newly formed tissue of the fetus and mother, the rate per unit mass of tissue not being materially changed."[5]

Rose says:

> Any increase in the amount of food required on account of the developing child before the end of the fourth month of gestation has been

[1] Van Blarcom, Carolyn, *Obstetrical Nursing*, 2d ed., The Macmillan Company, 1929.

[2] Sherman, E. C., *Chemistry of Food and Nutrition*, p. 182, The Macmillan Company, 1932.

[3] McLester, J. S. *Nutrition and Diet*, chap. X, pp. 297–302, 2d ed., W. B. Saunders Company, 1931.

[4] Wang and Hawks, Recent Studies of Basal Metabolism in Health and Disease, *Journal of the American Dietetics Association*, December, 1929.

[5] Proceedings of the White House Conference on Child Health and Protection, Section on Medical Service, Committee on Prenatal and Maternal Care, *U. S. Daily Supplement*, p. 59, Apr. 6, 1931.

shown to be insignificant. Beginning with the fifth month, growth is increasingly rapid up to the time of birth, but the actual amount of building material needed day by day is not very large, nor even in the last weeks will the energy demands be increased more than 20 per cent or ⅕ of the mother's usual daily supply before pregnancy. A woman of sedentary habits will then need from 2,400 to 2,800 calories per day, while a woman who is usually active will probably be somewhat less so, and is seldom likely to require over 2,800 calories.[1]

As a matter of fact the optimum amount of food will vary with individual cases and in the same individual from time to time just as it varies in nonpregnant individuals. The woman who is thin, overworked, or overstrained at the beginning of pregnancy will require more food than is indicated by her metabolism formula in order to provide a margin for bringing her to normal condition. The woman who is inactive, or who is already overweight, will need to diet carefully, *under expert direction*, in order properly to build her child's body without increasing her own weight by the undesirable and burdensome accumulation of fat.

In general, an expectant mother should not make a fetish of the subject of diet. She should neither "stuff nor starve." If she is in good health at the onset of pregnancy and accustomed to eating a varied and well-balanced diet, and if she observes a correct regimen in sleep and exercise, she need make no radical change. Certain emphases on minerals, vitamins, and protein will be indicated in subsequent pages. Her appetite will probably be a fairly reliable guide to her needs. McLester says: "The pregnant woman should eat just as any other woman should eat who would preserve full health and vigor."[2]

She should try to be intelligent in the matter and then enjoy her food without worry or apprehension. *Under no consideration should she undertake to modify her diet or make any deviation from the standard, balanced diet without the specific advice and direction of her physician.*

Kinds of Food. *Proteins.*—Protein plays a large part in the composition of protoplasm, "the stuff of life," hence it is impor-

[1] Rose, Mary Swartz, *Feeding the Family*, pp. 99–100, The Macmillan Company, 1929; also Mary Swartz Rose, *Foundations of Nutrition*, p. 447, The Macmillan Company, 1927.

[2] McLester, *op. cit.*, p. 297.

tant in the life of the living organism (see pages 17–19 chap. I). We are not surprised to discover that it constitutes an important factor in human diet, and that it is particularly important in the diet of the mother during pregnancy and lactation. Protein foods are composed of carbon, hydrogen, and oxygen, plus nitrogen and a great variety of mineral salts and other accessory substances. It is the only food substance containing nitrogen. There can be no formation of new cell nuclei and cell cytoplasm, and no renewal or repair of these structures, without the presence in the blood stream of the nitrogen bearers, the amino acids from which the various proteins are constructed. When protein foods are digested they are broken up into their component amino acids and these substances circulate in the blood and lymph. The various cells and tissues of the body then pick up the particular amino acids (sometimes likened to "building blocks") which they require for the construction of their own particular proteins.[1]

At least 5 of the 22 known amino acids are indispensable to the construction of animal protein in the tissues and to the preservation of chemical balance. These are tryptophane, tyrosin, lycine, cystine, and histadine. There may be others which are indispensable, and there may be more than 22 amino acids. As these 5 indispensable amino acids do not appear among those forming the proteins found in most of our foods of vegetable origin, or in gelatin, they must be provided in animal foods (other than gelatin). Protein foods lacking these essential amino acids are said to be "incomplete." We instinctively "complete" our vegetable proteins by adding bacon or pork to beans; and eggs, cheese, and milk to many vegetable dishes. This is one important reason for using milk and eggs liberally in household cookery.

When the amino acids have circulated in the blood stream and the various tissues have taken out what they require, the surplus is broken down or "deaminized" in the liver. The same process goes on in the various cells as they perform their various functions. The carbon, hydrogen, and oxygen are then free and to a limited extent may form carbohydrates, which become a source of energy and fat and may be stored; the nitrogen is released and

[1] Howell, William H., *Textbook of Physiology*, pp. 931–932, 937, W. B. Saunders Company, 1931.

assumes chiefly the form of urea (82 to 88 per cent) a relatively harmless substance which is then excreted by the kidneys. Some of the nitrogen assumes the form of ammonium salts (2 to 6 per cent), also excreted by the kidneys, while the remaining part, which normally is small, is excreted as uric acid and purin bases and certain other waste products. A diet which contains an excess of purin-rich protein, and in which the proteins are not wisely selected, may result in, or aggravate, various toxemias, the most serious of which is the "uremic poisoning" of pregnancy (see page 223).

While only about 10 per cent of the entire food utilization of the body assumes the form of tissue building and repair, the remainder being burned or oxidized to produce energy, yet the fact that we cannot identify and select with any accuracy the great variety of amino acids required by the millions of cell nuclei of the body makes it necessary to provide a margin of safety or surplus. Hence it is usually stated that 10 to 15 per cent of the total caloric intake should be selected from protein sources and that some of this must contain the indispensable amino acids, and that the protein quotient should comprise a liberal variety of food stuffs in order to meet the varied requirements of all the body cells.[1]

The protein requirement of woman is known to be greater during the reproductive cycle than during the rest of adult life, but it is difficult to make a precise determination of the protein requirement for any stage in the life cycle. The requirements for human reproduction can only be stated tentatively and within wide limits; for pregnancy 25 to 50 grams in addition to the maintenance allowance of 40 to 60 grams, and for lactation an additional 50 to 100 grams depending upon the quality of milk produced.[2]

It is generally agreed that the pregnant woman should consume daily, during the later months of pregnancy, 100 grams or more of carefully selected protein.

[1] Raymond Pearl is quoted by William A. Shaffer in the *Journal of the American Dietetic Association*, December, 1927, as stating that between the years of 1911 and 1918 the net human food consumption in America was: carbohydrate 52 per cent, fat 34.5 per cent, protein 13.5 per cent.

[2] Proceedings of Section on Medical Service of White House Conference on Child Health and Protection, Committee B, Prenatal and Maternal Care, *U. S. Daily Supplement*, p. 59, Apr. 6, 1931.

Protein Selection.—The chief sources of complete proteins are milk curd, egg white, fish, fowl, muscle meat, and edible animal organs. *Gelatin* is an animal protein, but it lacks cystine and tryptophane and other important amino acids, and cannot be used alone to complete the protein balance, although it is valuable for variety and is easily digested.

Meat protein forms more uric acid and purin bases than do most other proteins; also, meat is deficient in calcium and in vitamin C. Moreover, meat is relatively expensive. Meat, therefore, should be used sparingly in the diet of pregnancy, certainly not over once daily and that in small portion, and toward the last of pregnancy, when the kidneys are having the heaviest work to do, meat should usually be omitted entirely.

Egg white, while it does not set up digestive disturbances (except in case of sensitization) is not so completely absorbed as are most other proteins, being only 85 per cent utilized under usual conditions.[1] Because it is bland and does not produce excessively toxic waste, and also because the accompanying egg yolk is valuable for many reasons, egg white is an important source of indispensable amino acids in the balanced diet.

Milk protein, because of its digestibility and low toxic product, and because milk contains so many other necessary food factors, is the most valuable source of protein in the diet of pregnancy. McLester says the pregnant woman should have one quart of milk daily plus two eggs or one small piece of meat, in order to provide for the desirable protein quotient in the diet.[2]

Vegetable Proteins.—Legumes, such as beans, peas, peanuts, and lentils, are rich in protein. All seeds and grains contain varying amounts, but, as has been said, are deficient in the essential amino acids. Other organic foods do contain protein, of course, since protein is essential to living organization, but the amount is small and is commonly ignored in rough practical estimates of protein in a given dietary. Vegetables in general are important sources, but cannot be depended upon for the entire protein quotient because of their deficiency in the essential amino acids.

[1] Rogers, C. G., *Textbook of Comparative Physiology*, p. 342, McGraw-Hill Book Company, Inc., 1927.

[2] McLester, *op. cit.*, p. 301.

Fats.—Fat constitutes the most highly concentrated source of energy in the body. Fats are composed of varying proportions of hydrogen, carbon, and oxygen, which are liberated in the process of digestion in the form of fatty acids and glycerol, in somewhat the same manner that amino acids are liberated in protein digestion. These are recombined in the process of absorption to furnish fuel for running the cell-engines of the body and also to form the various tissue fats. The surplus is stored in the familiar form of body fat. The body uses the stored fat for cell fuel whenever the current fuel supply in food runs low. A moderate reserve of this nature is advantageous. An excessive amount results in disturbance of metabolic balance and in interference with the mechanical efficiency of tissues and organs, as in the case of a "fatty heart."

Imperfectly oxidized fats create a toxic condition characterized by the appearance of acetone bodies in the urine and known as *acetonuria.* This is one type of *acidosis,* or *ketosis.* The favorable balance between fat and carbohydrate is upset in diabetes, starvation, some fevers, and sometimes in the high fat (ketogenic) diet frequently used in the control of epilepsy. Such conditions may exist incidentally in pregnancy; also, too much fat in the diet or the imperfect digestion of fat during pregnancy may lead to imbalance with the carbohydrates and produce vague toxemia or acidosis.

Fat Selection.—The most valuable fat in the diet of pregnancy is milk fat as found in whole milk, cream, butter, and full-cream cheese. It is easily digested and has the advantage of being a rich source of the fat-soluble vitamin A. It also contains a variable amount of fat-soluble vitamin D, according to the diet and irradiation of the milk-producing animal.

Animal and vegetable fats such as suet, lard, olive oil, and corn oil are valuable sources of energy, but are almost entirely lacking in vitamins. Butter substitutes have a variable vitamin content according to the materials used in their manufacture. Before substituting any compound for butter its composition should be investigated, as a serious deficiency in fat-soluble vitamins may result unless the deficiency is supplied from other foods.

Amount of Fat.—Approximately 30 to 35 per cent of the total calories should be furnished from fat. As fats are highly con-

centrated this does not represent a large bulk. If a desirable amount of whole milk, cream, and butter are used, together with some vegetable salad oil, and the fat in the egg yolks eaten, the requisite quantity will be supplied without the use of fat in cooking.

The use of cooking fats to excess retards digestion, and may cause active indigestion. Normally, starches are partially digested in the mouth and stomach by the digestive ferment ptyalin in the saliva (this is one reason for chewing the food thoroughly). If the carbohydrate foods are not thoroughly mixed with saliva their digestion must take place almost entirely in the intestine. Since the salivary enzyme does not act upon fats, a coating of fat (as in pastry and fried foods) retards or prevents this salivary action upon carbohydrates.

Carbohydrates (*Sugars, Starches, and Cellulose*).—The carbohydrates, like fats, are composed of varying proportions of carbon, oxygen, and hydrogen. The hydrogen and oxygen, however, are usually combined in the proportion to form water, H_2O, hence *hydrates.* Along with the starches and sugars, large and variable amounts of vitamins, minerals, and other accessory substances are found in most fruits, vegetables, and grains in their natural form, a fact which greatly increases their food value. All carbohydrates are manufactured in plant-cell laboratories, and the chief sources for the human diet are from plant foods. Some carbohydrate is stored in edible animal tissue, as glycogen in muscle fiber and liver, and in milk as milk sugar, and thus animal food may provide a variable proportion of the carbohydrate ration according to the amount of animal foods consumed.

Sugars and starches differ from each other in flavor and solubility. The sugars have a more or less pronounced sweet flavor, and are, in general, much more readily absorbed in the process of digestion and assimilation. All *starches* and some *sugars* are *colloidal;* this means that their molecules are too large to pass readily through the intestinal membranes. They must therefore be reduced to sugars, and all sugars must be reduced chiefly to the very simple form of sugar known as *glucose* (*dextrose, grape sugar*), before they can be utilized in the body.[1]

[1] Culver and Rogers, *Organic and Food Chemistry*, p. 134, P. Blakiston's Son & Co., 1929.

Glucose along with other simple sugars leaves the digestive tract and goes directly to the liver through the portal vein. The liver stores it as a complex carbohydrate called glycogen (also called *liver sugar, animal starch,* etc.). The liver, under the check and stimulation of the pancreatic, adrenal, and pituitary hormones (see chap. VII, Glands of Internal Secretion), releases sugar, again reduced to the form of glucose, into the blood stream, keeping the blood sugar normally at the very fixed concentration of 0.1 to 0.15 per cent. Under emotional strain, excessive excretion, and disease, this percentage may be increased.[1]

If, from an excess in the diet, more sugar is forced into the liver through the portal circulation than the liver can manage, the surplus appears in the urine. This is called *alimentary glycosuria*, and is usually temporary, as distinguished from chronic glycosuria or diabetes.

Usually any surplus of sugar is converted into fat and stored as body fat. Some sugar is formed in the muscle tissues in the form of glycogen, a very small concentration, but since the muscle mass of the body is so large compared with the liver, it is estimated that there is approximately as much glycogen in the muscle system at any given time as will be found in the liver. This, of course, furnishes the fuel for muscle activity, and is quickly renewed by the blood.

The carbohydrates in the tissues are almost completely burned as fuel, being converted into carbon dioxide, which is a gas, and water. Carbohydrates actually provide most of the energy required by the body engine. The tissues oxidize (burn) the carbohydrate fuel first by preference, and consume the fat fuel next. Protein (see page 164) provides carbohydrate for fuel to a limited extent.

Carbohydrate Selection.—In the light of the large use of carbohydrates in the body the selection of carbohydrate foods in pregnancy becomes a matter of importance.

The concentrated sugars, while readily absorbed, cannot be advantageously used for any considerable part of the carbohydrate quotient because they are irritating to the membranes of the digestive tract; they readily ferment and disturb the chemical balance in the intestinal laboratory. Concentrated sugar has a value in exceptional situations in which a quick supply of excess

[1] Howell, W. H., *op. cit.*, p. 936.

fuel is needed, as in athletic contests, or prolonged exertion under food shortage, as in marching or battle. Under normal conditions the digestive mechanism does not require, and is not prepared to use, carbohydrate in this form to the best advantage. Concentrated sweets are habit forming, tending to create a craving for themselves rather than for other, more wholesome foods. Concentrated sweets, because of their quick absorption, dull the appetite by creating a sense of satiety, and may lead to an insufficient total food intake. Concentrated sweets, especially, have been deprived of the vitamins and minerals and cellulose which accompany them in a natural state, and one who consumes these in excess is very likely not to obtain enough of these indispensable factors. *On the whole a very limited use should be made of sweets in the diet of pregnancy.*

Fruits of all kinds and certain vegetables, such as beets, carrots, and sugar cane (as molasses and syrups), furnish the most important source of sugar in the human diet.

Cereals, seeds, tuberous and root vegetables supply the bulk of the starches. The starches are bland and nonirritating, and the prolonged digestive process tends to provide a steady supply of fuel and thus does not suddenly overwhelm the liver, a thing which may be brought about by the abrupt ingestion of a quantity of soluble sugar.

Like sugars, the starches as they occur in natural foods are accompanied by important minerals and cellulose, and also by proteins and certain vitamins (see page 166). Among the starchy foods those which provide a maximum amount of the important accessory factors are the whole-grain cereals and breads, and root and tuberous vegetables.

Cellulose (*"Roughage"*).—All sugar and starch granules in nature are encased in an insoluble wrapping or supporting carbohydrate substance known as cellulose. Cellulose is softened by the hydrochloric acid of the stomach and by other digestive fluids, thus releasing the soluble nutritive substances enclosed. Cellulose itself is not digested or absorbed (except to a limited extent in the lower bowel) and has little or no nutritive value.[1] It is softened by heat in cooking. This explains in part the increased

[1] SHERMAN, H. C., *Chemistry of Food and Nutrition*, p. 25, 3d ed., The Macmillan Company, 1928.

digestibility of properly cooked foods.[1] Cellulose does have a distinct use, however, in providing loose bulk and thus rendering the food mass porous so that it may easily become saturated with the various digestive fluids. It thus stimulates the mucosa (lining) of the intestine in such a way that the worm-like peristaltic movement of the bowel is continuous. *It is highly important that the food mass be kept moving;* this is Nature's way of securing complete digestion and preventing excessive fermentation and putrefaction. Pregnancy imposes mechanical difficulties to this free peristalsis (see page 228). It is therefore particularly important that the contents of the bowel should be correct in composition. Constipation commonly follows reduction in the cellulose content of the food. A common remedy for this type of constipation is agar (a dried sea moss), which provides nonirritating bulk, but which has no food value. Certain faddists use bran for this purpose. A good many nutritionists and physicians now advise against the use of bran both because it is irritating to the bowel, and, in some cases, may pack or adhere to the intestine, and also because it has little food value in itself and may only replace nutritious articles of food which might also provide roughage.[2] On the other hand, Dr. Rose, in an experiment with normal college women, found no injurious effect.[3]

The liberal use of fresh fruits, raw salads, whole-grain bread and cereals, leafy and root vegetables will incidentally provide an abundance of stimulating but nonirritating bulk and roughage.

Amount of Carbohydrates.—Approximately 50 per cent of the total calories should be selected from carbohydrate sources. On account of the bulky character of carbohydrate foods the apparent proportion is even greater than this. On the whole a wide variety is advantageous. For various reasons a diet would not be well balanced in which the carbohydrate quotient was selected entirely from either fruits, grains, leaves, or roots. It is better practice to include some from each class in each day's diet.

[1] MacLeod and Nason, *Chemistry and Cookery*, p. 366, McGraw-Hill Book Company, Inc., 1931.

[2] Lusk, Graham, *Science of Nutrition*, pp. 51–52, 4th ed., W. B. Saunders Company, 1928.

[3] Rose, Mary Swartz, MacLeod and Others, *Journal of the American Dietetic Association*, July, 1932.

Water.—"Water is vitally important in nutrition. Measured by the urgency of demand and promptness with which disaster follows failure of supply, it is of greater importance than ordinary food stuffs and is second only to oxygen."[1] "Water is the one best solvent adapted to further the peculiar group of phenomena that we call life. It is the only general solvent for inorganic salts. Although many organic compounds, for example fats, require organic liquids such as alcohol and ether for solvents, the majority of organic compounds are soluble in water."[2] Water not only holds the sugars, amino acids, salts, and bases in solution but it also provides the most favorable medium for the very important electrolytic activities (electrical changes) of the various body substances. While water itself is amphoteric or neutral, certain compounds when placed in water tend to separate into positive and negative ions (see page 13, chap. I).

Water has great capacity for taking up and giving off heat, thus assisting in maintaining the constant temperature of the body. Dr. J. H. Kellogg likens the body to an internal-combustion motor with an automatic cooling device provided by the two million sweat glands, which, he says, evaporate a quart or more of water each 24 hours. He says that without this mechanism cell combustion would raise the body temperature to 150°, which would clearly be fatal to life.[3]

The importance of water is shown by the large proportion of water found in living tissue. The more active the tissue the higher the water content. The water content varies from 6 to 10 per cent for fatty tissues to 82 to 85 per cent for brain tissue, in which chemical and electrical changes must, obviously, occur with the greatest rapidity and facility. Water is found in the body as an essential component of the colloidal cell protoplasm ("living water," "bound water") and also as a means of transporting chemical nutriments throughout the body.[4] It also functions in the transportation and elimination of waste and toxic products (see pages 10, 16).

[1] McLester, *op. cit.*, p. 101.

[2] Mitchell, P. H., *General Physiology*, pp. 133–134, McGraw-Hill Book Company, Inc., 1923.

[3] Kellogg, John Harvey, The Body Cooling Mechanism, *Good Health*, June, 1931.

[4] Rogers, C. G., *Textbook of Comparative Physiology*, pp. 299–300, 304–305, McGraw-Hill Book Company, Inc., 1927.

Water is absorbed from the large and small intestine, and little or none from the stomach. It leaves the body through kidneys, lungs, skin, and bowel. In health and with a normal appetite and correct food habits, the balance between intake and output of water is fairly equal. When the outgo is increased the individual instinctively drinks more. Also, when one takes a large amount of fluid the excretion of urine and sweat increases in amount. While most of the water is obtained from food and fluids, some is formed in the body from chemical oxidations which lead to the recombination of hydrogen and oxygen in the right proportion to form water.

Amount of Water.—Extreme and dogmatic statements as to how much water should be drunk are found in many, if not most, treatises on diet. As a matter of fact, it is quite impossible for the ordinary individual to calculate his fluid intake in cooked foods, succulent fruits and vegetables, in milk and other beverages, and then calculate the exact number of glasses of water required to bring his intake up to the stated amount.

Granting that this might be done it would still be necessary to know the loss from perspiration, breath, and urine in order to know what the total fluid intake should be in order to balance the output. A little thought will show that these two factors must vary from person to person and in the same individual from day to day and hour to hour according to air conditions, activity, etc.

Although few people drink a distinctly injurious amount of water, it is highly probable that a good many who force themselves to drink the six or eight glasses stipulated by their favored authority may at times dilute digestive secretions, over-distend stomach and bowel, and even impair appetite and enjoyment of food.

For the pregnant woman (and all others) the following may be said to be a safe program:

1. Do not make a fetish of drinking "so many" glasses of water daily.

2. Arrange to have palatable, fresh, cool water easily available at all times. If this is not done one "puts off" drinking because of the effort involved and unconsciously curtails the day's total intake or does all her drinking at mealtimes, with consequent

distension of the stomach and possible limitation of amount of food eaten.

3. One should cultivate a liking for water and a habit of drinking between meals. One good rule is to take a drink (more or less than a glass, as one relishes) on first rising in the morning, and at other regular convenient intervals during the day.

If "the lady in question" will observe these simple rules, and will chew her food thoroughly and make a practice, so far as mealtimes are concerned, of drinking fluids chiefly at the end of the meal, after her food has been thoroughly mixed with saliva and gastric fluids, she may drink just as much or as little as her taste dictates and not burden herself with checking off the "seven glasses." It is true that the kidneys excrete daily, in the average normal individual, from 3 to 4 pints of urine. Adding the 1 to 2 pints of skin and lung evaporation to this, and remembering that two glasses fill a pint, it is easy to see that the average individual requires a rather large amount of total fluid intake. Any diminution in the daily amount of urine voided should be quickly noted, as this often indicates that more water should be taken.

Minerals (Ash).—When organic substances are burned there always remains a nonoxidizable residue of mineral or "ash." This represents in the human body varying proportions of a number of mineral substances which, in life, are found incorporated in the colloidal protoplasm, bone, teeth, and other body structures, and also in solutions in the various body fluids. These minerals are indispensable to the structure and function of the animal body, and are found to maintain very fixed proportions and relationships to each other and to the rest of the body. On page 13, chap. I, appears a table of the principal body minerals with their usual proportions as found in the human body.

It might be assumed that the various minerals were important in order of their total quantity in the body, but such is not the case. *All are indispensable, even to the minute traces of manganese and copper.* Without any one, or with a deficiency in any one, the chemical balance of the body is upset, and complete withdrawal or continued deficiency causes serious impairment or even death.[1]

[1] McLester, *op. cit.*, p. 109.

Acids, Bases, and Salts.—The ash residue from the complete oxidation (burning) of any organic substance will be acid, alkaline, or neutral (see page 14, chap. I). *Salts* are formed from the combinations of acids with bases. Salts are neutral in electrical and chemical reaction and have the characteristic "salty flavor."

Mineral Balance.—The normal reaction of the blood and protoplasm is nearly neutral; the amount of hydroxyl ions being slightly greater than that of the hydrogen ions, litmus paper is turned faintly blue. The maintenance of this chemical neutrality is extremely important. The range of variation compatible with health is very small. The "average normal hydrogen ion concentration [this term is used to express the acid-base relation (see page 14)] of blood plasma has been found to lie at or very near the slightly alkaline point of pH 7.4, and the range of reaction of blood compatible with life appears to be from about pH 7.0 to about pH 7.8."[1]

The never-ceasing chemical activity of the millions of body cells is continually hydrolizing, oxidizing, and neutralizing the structural and nutritional substances within the body. This neutralization is accomplished in part by "buffer" substances (sensitive mineral compounds, chiefly metallic bases or neutral salts) in the blood which give and take in both directions but principally by uniting with the acid products to form alkaline or neutral substances.

In part the balance is maintained by the kidneys, which have the property of excreting acid urine from the alkaline blood passing through their tubules; and by the liver, which releases alkaline ammonia in the deaminization of proteins. The energy in the body arises from oxidation of the foodstuffs. Various acids are formed in this process, lactic acid from the carbohydrates, B-hydroxybutyric and aceto-acetic acid from the fats, certain amino acids, or their derivatives from the proteins. Muscular exercise produces lactic acid. Unneutralized, these acids would raise the hydrogen ion content of the blood to a point incompatible with life. The chemistry of this buffer process is intricate and complicated and adds to the evidence of the importance of food minerals. Especially it makes us

[1] SHERMAN, *op. cit.*, pp. 289.

realize that the diet should not contain too high a percentage of foods which produce acid ash.

A given mineral may be present in the blood in acid or alkaline form and also as neutral salts. Sodium and potassium are alkaline minerals, and when present in large amounts, even though combined with organic acids as in many fruits, tend to produce alkaline ash and exert a buffer influence. This is the reason oranges, lemons, apples, and tomatoes are listed as alkali-producing foods in spite of their acid taste.

On the other hand, the oxidation products of the proteins and fats are acid; hence meats, eggs, fish, corn, cereals, and nuts are listed as acid-producing foods although having a bland flavor.

The starches and sugars are broken down ultimately into carbonic acid gas and water, the carbonic acid gas being exhaled from the lungs as carbon dioxide. Therefore concentrated sugars and starches are listed as acid-forming foods, while the fruits and vegetables from which they are derived are chiefly alkali-producing foods because of their mineral content. This is an additional reason for selecting, in general, foods as formed by Nature. The chemical adjustments of the body have been adapted to the utilization of natural foods through the eons of evolution. McLester says: "One of the most remarkable facts of physiology is the unvarying constancy with which the mineral content of the animal plasm has remained unchanged through all the ages."[1]

Milk is slightly alkali-producing in the body because of the presence of calcium, potassium, and sodium elements, although the litmus reaction of fresh milk is slightly acid. Certain foods, because of the presence of particular acids which do not readily combine with buffers, are distinctly acid-forming. Cranberries, prunes, and eggs belong to this class.

All of these facts simply supply additional evidence that the diet which includes too large a proportion of meat protein or concentrated starch or sugar is nutritionally unsatisfactory.

Selection of Minerals. *Calcium* (*Lime*).—Calcium constitutes the largest total of any body mineral, since it enters extensively into the structure of bones and teeth, and is also an essential constituent of muscles, blood, and nerves. In order to maintain

[1] McLester, *op. cit.*, p. 88.

Acid-producing Foods		Alkali-producing Foods	
Foods	Total c.c. of acidity over base per 100 grams	Foods	Total c.c. of base over acid per 100 grams
Bread	2.7	Almonds	12.38
Bread, whole wheat	3.0	Apples	3.76
Corn	5.95	Asparagus	.81
Crackers	7.81	Bananas	5.56
Egg white	5.26	Beans, dried	23.87
Eggs	11.10	Beans, lima, dried	41.65
Cranberries*	.....	Beets	10.86
Egg yolk	26.69	Cabbage	4.34
Fish, haddock	16.07	Carrots	10.82
Fish, pike	11.81	Cauliflower	5.33
Meat, beef, lean	13.91	Celery	7.78
Meat, chicken	17.01	Chestnuts	7.42
Meat, frog	10.36	Currants, dried	5.97
Meat, pork, lean	11.87	Lemons	5.45
Meat, rabbit	14.80	Lettuce	7.37
Meat, veal	13.52	Milk, cow's	2.37
Oysters	30.00	Muskmelon	7.47
Oatmeal	12.93	Oranges	5.61
Peanuts	3.9	Peaches	5.04
Prunes*	.....	Pears, dried	7.07
Rice	8.1	Potatoes	7.19
		Radishes	2.87
		Raisins	23.63
		Turnips	2.68

From McLester, *Nutrition and Diet*, pp. 479–480, after Sansum, Blatherwick, and Smith.

* The ash of these articles is alkaline in nature, but because of the sources of hippuric acid contained in them, they increase the acidity of the body.

the structure and metabolic integrity of these parts and organs a constant supply of calcium must be made available to the tissues. This involves provision of mineral or organic calcium from regular food sources. McLester and Sherman both say that the *mineral content of the American diet is more likely to be faulty in respect to calcium than to any other element.*[1] Graham

[1] McLester, *op. cit.*, p. 118; Sherman, *op. cit.*, p. 286.

Lusk says, "the ordinary American diet of the average inhabitant of the Eastern States, as studied by Sherman, Mettler, and Sinclair, presents a sorry spectacle" (as compared with certain foreign dietaries).[1]

While *the calcium of milk is the most fully utilizable, and is an indispensable source in pregnancy and lactation*, the calcium of carrots, lettuce, asparagus, celery, spinach, summer squash, and cabbage is also said to be well utilized. Milled cereals, meats, and concentrated sweets are lacking in calcium.

Calcium Metabolism.—Calcium salts in solution are carried to the tissues of the body in the blood serum. Calcium waste is carried out of the body in urine and feces. The tissues can utilize this calcium only if certain hormones are present, notably those from the anterior pituitary and the parathyroids (see pages 110, 115); and, furthermore, certain essential factors known as vitamins C and D (see pages 191–195) must be present. Calcium metabolism thus involves more complicated procedure than merely providing adequate mineral in the diet.

Amount of Calcium.—In general, the average adult person should receive approximately 0.75 gram of calcium daily. The growing child and the pregnant and nursing mother should receive much more accordingly. During the last 10 weeks of pregnancy the calcium needs of the fetus increase enormously. Macy and Hunscher have shown that there is likely to be negative nitrogen and calcium balance during the last weeks of pregnancy and the first weeks of lactation.[2] This means that the fetus withdraws from the mother's bones and tissues the essentials she is not providing in her diet (see pages 198, 227). Excessive reduction of blood calcium may cause nervousness, irritability, high blood pressure, and albuminuria[3] (see page 223, Toxemias of Pregnancy).

It is estimated that the pregnant woman should take not far from twice as much calcium during the last weeks of pregnancy

[1] Lusk, *op. cit.*, p. 481.

[2] Macy and Hunscher, *Proceedings of the Third Conference on Child Development*, Part II, National Research Council, 1929 (quoted by Dr. Charles Wilson) in the *Proceedings*.

[3] DeLee, Joseph, *Principles and Practice of Obstetrics*, p. 112, 5th ed., W. B. Saunders Company, 1930.

as she would usually require, or 1.1 to 1.4 grams per day.[1] This means a definite increase in milk and vegetables. Fortunately these also provide the increase in proteins, vitamins, and other minerals which are indicated at this time.

Phosphorus is closely associated with calcium in body structure and function. It is highly important that the ratio of phosphorus and calcium be kept constant. "The prolonged administration of calcium may result in harm unless accompanied by a physiologically equivalent amount of phosphorus."[2] It enters into the structure of bones, teeth, nerves, and all cell nuclei. Phosphorus is perhaps the most widely distributed in the human body of all the mineral elements (McLester). Phosphorus metabolism also depends upon the presence of vitamin D. Not much is known as to the relation of the endocrine glands to phosphorus utilization.

Since phosphorus is so essential to the structure and function of all protoplasmic cells, we are not surprised to learn that animal and protein foods are the richest sources of phosphorus. Lean meat, milk, cheese, and eggs are among the richest sources of food phosphorus; beans, nuts, whole wheat, and carrots also contain definite amounts.

Amount of Phosphorus.—While the total amount of phosphorus in the body at any time is less than that of calcium, it is less stable, and owing to the high activity of the nerve and muscle cells a relatively larger amount is consumed daily. It is variously estimated that 0.88 (Sherman) to 1.5 (McLester) grams per day are required by the average adult, with corresponding increase during the last of pregnancy. This will be provided by the increased use of milk as indicated for calcium. The diet is not apt to be deficient in phosphorus unless it is also deficient in protein.

Potassium, being an alkali or base-forming element, is one of the valuable "buffers" involved in maintaining the mineral balance in the body. There is a greater concentration of potassium salts in the cells of the blood and of sodium salts in the

[1] Rand, Sweeney, and Vincent, *Growth and Development of the Young Child,* p. 164, W. B. Saunders Company, 1931.

[2] Proceedings of White House Conference, Section on Nutrition, p. 86, *U. S. Daily Supplement,* Apr. 6, 1931.

blood serum. This doubtless has something to do with standardizing the permeability of the blood cells (prevents the cells from "dissolving" in the serum) and gives a hint as to the extreme importance of the "mineral balance."

Potassium tends to combine with sodium chloride and to hasten its removal from the body. Plant foods are rich in potassium; hence herbivorous animals require salt. This is the reason we instinctively "salt" potassium-rich foods such as beans, peas, and potatoes. Potassium is abundant in beans, peas, wheat, raisins, rice, potatoes, turnips, and is present in most vegetables. It is less abundant in animal foods. Tables of the principal mineral content of common foods will be found in most current texts on foods.

On account of its prevalence there is little or no danger of shortage of potassium in the diet.

Sulphur.—"Plants absorb sulphates from the soil and use the sulphur in the synthesis of proteins."[1] Most of the sulphur concerned in human metabolism is organic sulphur accompanying food proteins. Sulphur is a constant ingredient of one of the essential amino acids, cystine. Sulphur metabolism tends to run parallel with nitrogen (protein) metabolism. When proteins are oxidized in the body the sulphur is set free chiefly as sulphuric acid, which must be promptly neutralized by "buffers," and is excreted in the urine as sulphates. Before elimination the sulphates combine with certain putrefactive products of intestinal decomposition, particularly of purin-rich meats, and render these innocuous. These sulphates are therefore regarded as *detoxicating* agents which protect the body from "auto-intoxication."[2]

Since sulphur is found linked with proteins, there will be no shortage if the proper protein food balance is maintained.

Sodium.—Sodium salts occur abundantly in the blood and other fluids of the animal body and in much lower concentration in the tissues (Sherman), while potassium salts concentrate in the tissues. The normal balance between these has much to

[1] Sherman, *op. cit.*, chap. XI, p. 275, Inorganic Food Stuffs and Mineral Metabolism.

[2] Mitchell, *General Physiology*, pp. 129–130, McGraw-Hill Book Company, Inc., 1923.

do with regulating osmosis through cell membranes (see Potassium). Sodium is found in the body chiefly as sodium chloride (common salt), which is the neutral salt formed from the sodium base and the chlorine acid. Sodium chloride is found in the blood serum and other body fluids in the very constant concentration of 0.5 per cent. This is known as "normal salt" concentration. Curiously enough this is about the saltiness of sea water. Since this ratio is so very important in animal physiology we are not surprised to find a special mechanism for its regulation. This, we have been told (see page 117), is one of the functions of the posterior pituitary, more specifically of the beta-hypophamine hormone.

When the kidneys become disabled so that they are unable to carry off the waste chlorides (nephritis or Bright's Disease) the blood concentration is altered, the osmotic balance is disturbed and oedema, or retention of fluids (dropsy) in the tissues results. Reduction or elimination of salt from the diet gives some measure of relief and is a common medical procedure.

The White House Report, Section on Nutrition, says, "The possible significance of common salt in some of the chemical equilibria of the organism has barely begun to receive attention. It is closely interrelated with the retention and elimination of water. The indispensable rôle of water involves the inorganic salt metabolism as well as the acid base equilibrium."

The amount of salt required to maintain the normal saltiness of the body fluids depends very directly upon the amount of potassium in the diet, since the potassium is weighed, so to speak, in the other pan of the osmotic scale. We instinctively salt potatoes, beans, and other potassium-rich vegetables. Herbivorous animals run to natural salt licks where crystallized salt crops out of the earth. Carnivorous animals and Eskimos use no salt. Salting meat is an acquired habit with us, partly due to the use of salt primarily as a preservative. Dr. Helen MacMurchy, formerly chief of Canadian Division of Child Welfare, in the *Canadian Mother's Book*, advises rather rigid restriction of salt during pregnancy. The bulletin on Prenatal Care of the U. S. Department of Labor, Children's Bureau, says: "The amount of salt commonly used in cooking is sufficient for the expectant mother. She should not add salt at the table."

It is true that the average amount of salt used is in excess of the most liberal estimates of physiological requirement. Since the excess must be excreted by the kidneys, even though this does not appear to be particularly irritating or toxic, it is probably the part of wisdom to be moderate and use no more than the minimum amount of salt required to render food palatable.

Chlorine.—Chlorine is closely identified with sodium, as just discussed. Aside from the importance of the sodium-chloride-potassium balance in animal physiology chlorine is important because of the formation of hydrochloric acid, one of the important digestive secretions of the stomach. The acid glands of the stomach withdraw the necessary chlorine from the blood plasma and maintain, in health, the concentration of the gastric acid at a uniform percentage regardless of the amount of sodium chloride ingested in the food. As has been said, sodium chloride (table salt) is the chief source of chlorine in the food.

Iron, Copper, Manganese.—Iron, copper, and manganese are indispensable ingredients of the hemoglobin (the red coloring matter) of the blood cells.[1] The hemoglobin is the oxygen carrier in the animal body. It seems to perform a function similar to that of chlorophyll in the plant organism. Only recently has the close relationship between these minerals become known. It appears that a very minute amount of copper, and probably of manganese, must accompany iron or it cannot fully perform its important function.[2]

The total quantity of iron in the human body at one time is not large; 0.015 to 0.0175 gram of iron daily is the average human requirement. The turnover is rapid, however, and a constant supply from food sources is particularly important. This is due not only to the high activity and rapid destruction of the blood-iron, but also to the fact that there is no storage reserve as is the case with calcium and phosphorus in the bones. The only exception is the storage of iron in the liver of the new-born child, which is obviously intended to supplement the lack of iron in milk during the period of nursing.

[1] Roberts, Lydia J., Iron and Other Factors Important in Hemoglobin Formation, *Proceedings of the Third Conference on Research in Child Development*, National Research Council, Washington, D. C., 1929.

[2] Rose, Mary Swartz, What Place Have Aluminum, Copper, Manganese, Zinc in Normal Nutrition, *Journal of Nutrition*, July, 1929.

The formation of hemoglobin requires not only iron in usable form, together with the minute quantities of copper and manganese mentioned, but also certain amino acids, which will commonly be provided by a balanced food quotient, and in addition certain pigment radicals which are found in green leaves (chlorophyll) and in certain yellow pigments (carotin) in egg yolk, yellow corn, etc.[1] Although inorganic iron is now believed to be utilized if the other constituents are also at hand, the economy of providing a liberal portion of the iron quotient from leafy vegetables, egg yolk, and other sources supplying also the pigment radical will be recognized.

Hemoglobin is formed in the liver, the spleen, and the bone marrow. When hemoglobin breaks down, iron is eliminated chiefly by the bowel. The hemoglobin-forming factors seem to be particularly concentrated in the liver; for this reason liver or "liver extract" is prescribed in the diet for anemia. Iron is found in relatively large quantities in red meat, leafy vegetables, such as lettuce and spinach, egg yolk, oatmeal, beans, peas, and whole wheat, also to some extent in most fruits, notably peaches and apricots;[2] none of these is so effective as liver, however, in the treatment of anemia.

On account of the "hand-to-mouth" manner of maintaining the iron quotient, dietary deficiencies in iron are quickly felt, and in the cases of the pregnant and lactating woman and the growing child are serious. DeLee says that while grave anemias are rare, probably 30 to 50 per cent of pregnant women develop some degree of anemia.

Since there are objections, which have been stated, to the free use of meat or the too extensive use of the legumes and grains as sources of iron and other dietary essentials, and since milk, milled cereals, and most starchy vegetables have relatively little or no iron, the pregnant woman will have to give daily thought to the liberal use of the highly pigmented vegetables, especially the leafy vegetables, which contain, fortunately, not only iron, but also copper, manganese, and pigment radicals. Thus only can she maintain her hemoglobin ratio which is essential to all

[1] SHERMAN, *op. cit.*, chap. XIV. Iron and Copper in Food and Nutrition.

[2] HOWELL, W. H., *Textbook of Physiology*, p. 969, 11th ed., W. B. Saunders Company, 1931.

energy production (oxidation). She must not only provide for the fuel combustion in her own body but for that within the increasingly active body of her child.

Manganese.—In addition to the relation between manganese and iron metabolism indicated above, recent research seems to indicate a close relation between manganese metabolism and the reproductive functions which are affected by the anterior lobes of the pituitary.[1] Manganese is required in very small amount, and is so universally present in food substances that there is no danger of deficiency in the human diet.

Iodine.—Iodine is another element essential to life which is maintained at a fixed concentration in the blood stream under normal conditions. This concentration is only about one part in three millions, but its presence is indispensable to life and function.[2] Since iodine participates in the most active chemical changes in the body, and since it is not stored, except to a limited extent in the thyroid, a constant supply is necessary in food. Iodine metabolism is regulated by a special organ, the thyroid (see page 110). Iodine is made available to the tissues by the hormone thyroxin. It is particularly active in growth and in the functioning of the sex glands, especially in the female; hence the importance of iodine in the diet of infancy, adolescence, pregnancy, and lactation will be apparent.

The original source of iodine is the sea. The iodine concentration in the animal blood stream is, like the sodium chloride concentration, approximately that of sea water. When the sea receded from the land the soil was left more or less saturated with the iodine solution, as well as with sodium chloride. It is the supposition that the rains have washed this out of the soil in certain regions, particularly those regions fed by glacial streams. The water and the vegetation are correspondingly lacking in iodine content. Susceptible individuals living in these regions develop characteristic hypothyroid symptoms (see page 109).

[1] McCollum and Orent, Effect of Deprivation of Manganese in the Rat, *Journal of Biological Chemistry*, August, 1931.

[2] References on iodine: Sherman, *op. cit.;* Stieglitz, J., editor, *Chemistry in Medicine*, chap. VI, by David Marine, The Chemical Foundation, Inc., 1928; Mitchell, *op. cit.;* Rose, Mary Swartz, *The Foundations of Nutrition*, The Macmillan Company, 1929.

Sea foods, iodine-rich vegetation, and milk from cows or goats eating iodine-rich vegetation are the best sources of food iodine. Water, except in goitrous regions, contains iodine. The addition of iodine to table salt has become an extensive manufacturing practice. When the iodine content of the salt is standardized, and where a dietetic deficiency exists, the use of iodized salt is probably to be commended.

In general, the pregnant woman who uses the full quotient of milk recommended, and who makes liberal use of leafy vegetables, with the occasional use of sea foods especially during the last months of pregnancy, will, unless she lives in a goitrous region, be reasonably sure of receiving sufficient iodine. There is probably no objection to the use of iodized salt during pregnancy if no symptoms of hyperthyroidism are present.

Magnesium.—This mineral is also found in a small but constant concentration in the body fluids. The maintenance of a certain balance between the calcium-phosphorus ratio and magnesium ratio seems to be important. In the absence of magnesium, calcium and phosphorus are drained out of the body. In McCollum's rats not enough mineral was left to cast a shadow with the *x*-ray. Here again evidence points to hormone regulation, possibly vested in the adrenal cortex.[1] Magnesium is relatively abundant in meat muscle and most plant tissues. There is little danger of magnesium shortage in any ordinary dietary.[2]

Flourine and Silicon.—Little is known of the significance of these minerals, which are found in small quantities in bones and teeth. Silicon is abundant in hair and feathers. Possibly their function is to give rigidity to these structures. Milk contains traces of both minerals. Vegetable fiber is also a source. There is little danger of dietary shortage when milk and vegetables are used.[3] In certain regions where an excess of flourine is found in the water the teeth of all young animals and infants are found to have "mottled" and defective enamel. It is necessary to protect growing children in these regions by the use of distilled or imported drinking water.

[1] *Science News Letter*, Apr. 18, 1931, abstract of Dr. McCollum's report.
[2] SHERMAN, *op. cit.*, p. 245.
[3] MITCHELL, *op. cit.*, p. 128.

Vitamins, "Plant Hormones," "Accessory Food Factors," "Protectives."—Vitamins are minute but potent factors, resembling in their potency and importance catalysts, enzymes, and hormones, which are found in varying concentrations in most organic food substances in their natural state, and without which the metabolism of the living organism cannot be maintained. "They are to the human machine what the ignition spark is to the automobile."[1]

Although Eijkman in 1887 saw that some active principle in rice hulls cured beri-beri, the first "accessory food factor" (afterward called vitamin B) was really discovered by Hopkins in 1906. This opened a new chapter in the science of nutrition. The factor was first named *vitamine*, (vital amine) under the impression that a nitrogenous amine had been discovered which was essential to life. Since all vitamins do not contain nitrogen, and the chemical character of several is still in doubt, the final *e* (denoting in scientific nomenclature that the nature of the substance is established) has been dropped and the term vitamin is now universally accepted. Mendel and Lusk suggest that the term "food hormone" would be preferable to the terms commonly used.[2]

There are at least six vitamins which have been identified by their effects and traced to their sources. Vitamins A, C, and D are reported to have been isolated and analyzed chemically, and potent concentrates of several have been made. For the most part, however, knowledge of vitamins depends upon the standardized feeding of experimental animals and clinical observation of human nutrition.

Absence or restriction of vitamins in the diet produces effects known as *deficiency*. An entire class of "deficiency diseases" is now recognized in medicine.

Vitamin A, "Growth and Immunity Vitamin," "Anti-xerophthalmic Vitamin."—Vitamin A was the first vitamin to be named and conclusively reported (1913) by McCullom and Davis, and also by Mendel and Osborn. It is soluble in fat solvents such as

[1] Macleod, Annie Louise, *Chemistry for Nurses and Students of Home Economics*, chap. XXIII, McGraw-Hill Book Company, Inc., 1928.

[2] Lusk, Graham, *Science of Nutrition*, 4th ed., p. 522, W. B. Saunders Company, 1928.

ether and alcohol but not in water, hence "fat-soluble." Vitamin A is always associated with sterol,[1] but is probably not a true fat. It was believed to be manufactured (synthesized) wholly by plants and stored only in the animal organism until the discovery of the rôle of carotin in the vitamin A picture made it seem possible that the animal body may also synthesize it in the presence of the yellow pigment radical, carotin, which must, however, be provided from plant sources.[2] Nevertheless, it is found in greater concentration in animal than in plant food.

Recent reports indicate that vitamin A has been isolated in crystalline form.[3] Up to this time it has been impossible to obtain it even in concentrated form, and it has been necessary to rely entirely upon natural foods for feeding and experimentation.

Vitamin A is *stable* to heat and alkalies but *labile* (susceptible) to oxygen and ozone and is destroyed by irradiation with ultraviolet light.

Vitamin A is found stored in the liver and other glandular tissues, egg yolk, and milk in proportion to the amount ingested with the food.

A number of investigators have noted that vitamin A is usually associated with the yellow-pigment radical, carotin (also carotene), and it appears that this yellow pigment must be either identical with this vitamin or, more probably, is a *pro-vitamin* from which the plant (and possibly the animal) synthesizes the vitamin.[4] This is not yet accepted by certain investigators, who believe that vitamin A is found in some foods in the absence of carotin.[5] However, the fact that the highly pigmented foods are

[1] Mendel, Lafayette B., Vitamin A, *Journal of the Americal Medical Association*, June 4, 1932; White House Conference Reports, *Nutrition*, Part III, p. 126, Growth and Development of the Child, D. Appleton-Century Company, 1932.

[2] Mendel, Lafayette B., *op. cit.*

[3] Vitamine A and Pigment, editorial, *Journal of the American Medical Association*, Jan. 5, 1929; Carotene and Vitamin A, editorial, *Journal of the American Medical Association*, July 18, 1931; Moore, T., Vitamin A and Carotene, *Biochemical Journal*, vol. 23, 1929.

[4] White House Conference Reports, *Nutrition*, Part III, p. 123, Growth and Development of the Child, D. Appleton-Century Company, 1932.

[5] Smith, Sybil L., Unscrambling the Vitamins, *The Medical and Professional Women's Journal*, June, July, 1933.

the richest sources of vitamin A is a useful guide in food selection.

The function of vitamin A seems to be intimately related to growth, and specifically to the normal development and normal health and function of the mucous membranes of the eyes, sinuses, respiratory, renal, and digestive tracts, with particular reference to their impermeability to infective organisms. *Vitamin A is strongly protective against infections which enter the body through the membranes.* Its immunizing property may depend upon the health of the membranes rather than upon any immunizing effect upon the body fluids, although it is possible "that vitamin A may after all do more than maintain the physiologic defenses of the mucous membrane."[1] Vitamin A "serves both as a tissue-building and as a regulatory substance. It is essential both to the growth and development of the body, and to the orderliness of the nutritional processes which go on at all ages."[2]

Deficiency of vitamin A lowers the permeability of the membranes to the entrance of infective germs. In extreme deprivation a specific eye disease known as "xerophthalmia" develops. Lesser degrees of deficiency show as heightened susceptibility to colds, ear and sinus infections, pneumonia, influenza, tuberculosis, ulcerative colitis, diarrhea, and urinary calculus (stone in urinary bladder). While all of these effects are probably chiefly due to the impairment of function in the various lining membranes, it is possible that the vitamin contributes some immunizing factor to the fluids of the body. Night blindness is also related to vitamin A deficiency.

With the impairment of the membranes of the reproductive tract, fertilization and implantation of the ovum may be prevented and sterility result.[3]

Deficiency of vitamin A causes arrest of growth and malnutrition, probably due indirectly to the injury to the digestive and assimilative mechanisms.

The sources of vitamin A are primarily certain animal fats, especially milk fat (butter, cream, cheese, and whole milk) and liver oils. The highest available concentration is found in

[1] Is Vitamin A an Antiinfective Agency? editorial, *Journal of the American Medical Association*, Oct. 24, 1931.

[2] SHERMAN, *op. cit.*, chap. XVI, Vitamin A.

[3] MCLESTER, *op. cit.*, p. 318.

cod-liver oil. Vitamin A is not found in appreciable amount in vegetable and body fats such as olive oil, suet, lard, and tallow. For this reason most butter substitutes (margarines) are seriously lacking in vitamin A. It is important that the composition be known of any substitute for butter which is used, and that any deficiency be supplemented from other foods. This is particularly important during growth periods, such as pregnancy, nursing, childhood, and adolescence.

Other important sources are the yellow vegetables such as carrots, sweet potatoes, squash, yellow turnips, and yellow corn (very little in white potatoes, turnips, and corn). In green leaves the yellow pigment is covered up by the green coloring matter, but most edible green foods are rich in vitamin A.

The pregnant and lactating woman will need to make liberal use of milk and milk products and yellow and green vegetables if she is to keep her immunity at a high level and supply her child with full impetus to grow.

Vitamin B Complex.—The first vitamin to be recognized was vitamin B (first called *accessory food factor*) which was identified by the fact that absence of this factor in the diet produced a nervous disorder called *polyneuritis* or *beri-beri*, and that prolonged deficiency arrested growth. It is now recognized that the original vitamin B can be separated into a *heat-labile fraction* which directly affects appetite, digestion, and nervous function, and a *heat-stable fraction* which may prevent pellagra,[1] and there is some evidence that these fractions may be divided into still more specific parts.

Various terms have been suggested for these two new vitamins, and considerable confusion exists at the present time on this account. A committee of the American Society of Biological Chemists proposes that these be named B and G respectively, and these terms seem to be coming into general acceptance.[2] In reading, one should try to be clear as to whether he is reading about the original "B complex" or about one of its later discovered fractions.

[1] Sherman, H. C., Nutritional Significance of Our Present Knowledge of the Multiple Nature of Vitamin B, *Journal of Nutrition*, November, 1928.

[2] Smith, Sybil, Vitamins B_1 and B_2, *Ladies' Home Journal*, February, 1931.

Vitamin B, B_1, F, "Appetite Vitamin," "Hunger Vitamin," "Antineuritic Vitamin," "Anti-beri-beri Vitamin."—Vitamin B is water-soluble, is easily destroyed by heat and alkali, is not stored in the body, and is probably not synthesized (manufactured) in the body. The isolation of vitamin B in crystalline form has been reported from several sources, but there is not yet complete agreement as to formulas.[1]

The function of vitamin B seems to be to maintain the normal functions of the nervous and digestive systems. Vitamin B is an essential component of cell nuclei. Certain deficiency symptoms may be due to nuclear starvation.[2] It is generally believed that vitamin B plays some part in the oxidation of carbohydrates in the tissues, particularly in brain and nervous tissue (see Smith, *op. cit.*).

In relation to reproduction vitamin B seems to be essential to lactation and to glandular function. Nursing mothers require greatly increased amounts, even three to five times the regular amount of vitamin B in order adequately to protect their nurslings.[3]

Deficiency of Vitamin B, if extreme, produces polyneuritis or beri-beri, characterized by progressive degeneration of the nervous system ending in paralysis and death.[4] Milder deficiency may simulate the joint pains of rheumatism, impair the appetite (anorexia)[5] and impair nutrition, especially of the growing child, resulting in arrest or loss of weight. Dr. Hoobler describes a child who is experiencing vitamin B deficiency as "a pale, undernourished, fretful, whiney, spastic [convulsive or spasmodic] infant who consistently refuses much of his food."[6] General

[1] Smith, Sybil L., *op. cit.*, pp. 139–140.

[2] White House Conference Reports, *Nutrition*, p. 138.

[3] Hoobler, B. Raymond, Use of Vitamin B in Diets of Infants, *Journal of the American Medical Association*, Feb. 28, 1931; Macy and Outhouse, Vitamin B in Infant Feeding, *Journal of Biological Chemistry*, vol. 23, 1927.

[4] Sandels, M. R., Experimental Polyneuritis in the Rat, *Journal of Nutrition*, March, 1930.

[5] Sure, Barnett, A Detailed Study of the Rôle of Vitamin B in Anorexia in the Albino Rat, *Journal of Nutrition*, September, 1928.

[6] Hoobler, B. Raymond, An Attempt to Define the Symptomatology of Vitamin B Deficiency in Infants, *Transactions of the American Pediatric Society*, American Medical Association Press, 1928.

atony (inactivity) of the intestinal tract is marked, and leads to constipation, colitis, appendicitis, and other digestive disorders. The heart and adrenals hypertrophy. Vitamin B deficiency is said even to lower the threshold of learning.[1]

Plimmer and Rosedale have observed that large doses of cod-liver oil must be compensated by an increase in vitamin B. Also, an increase of carbohydrate, fat, or protein must be accompanied by increase in vitamin B. "At least half the daily diet must consist of whole meal flour or whole cereal or pulses [seeds, legumes] to avoid symptoms from the heart or gastro-intestinal tract." They state that the everyday diet, consisting mainly of white flour, sugar, fat, and meat, does not contain an ample supply of vitamin B, and they consider it very likely that the cardiac disorders, constipation, and gastrointestinal symptoms and appendicitis so common in the population are produced, in part at least, by a deficiency of vitamin B in the daily food.[2]

Vitamin B concentrate is being produced commercially in several forms such as tiki tiki, the extract of rice hulls; wheat-germ sugar (vitavose); concentrate of brewer's yeast, etc. Some use is being made of these concentrates in protecting infants from vitamin B deficiency in the same manner that cod-liver oil, viosterol, and orange juice are being used to supply vitamins A, C, and D. It is too early to know certainly as to the efficacy and desirability of using such protectives.

Wheat germ, all seed germs and oils, yeast, whole grains, cereals, and eggs are sources of vitamin B. There are variable amounts of vitamin B in human or cow's milk according to the maternal diet. In general, vitamin B (B_1 or F) is found in the seeds of the plant while G (B_2 or P-P) is found in the roots and leaves. Sherman says all fruits and vegetables contain vitamin B.[3]

Vitamin C, "Dental Vitamin," "Antiscorbutic Vitamin."—Vitamin C is water-soluble and is speedily destroyed by heat in the presence of oxygen or alkalies, although heating in a vacuum,

[1] Maurer and Tsai, The Effect of Partial Depletion of Vitamin B Complex upon Learning Ability in Rats, *Journal of Nutrition*, November, 1931.

[2] Abt, Isaac, editor, *Practical Medicine Yearbook of Pediatrics*, 1927; Plimmer and Rosedale, Ill Effect of Large Doses of Cod-liver Oil, p. 368.

[3] Sherman, *op. cit.*, p. 390.

as in modern canning and milk-drying, seems to produce little injury. For this reason vegetables should not be overcooked, and should be cooked in a vacuum kettle if possible. Furthermore, one should not add soda to tomatoes in cooking as was formerly a custom. Vitamin C is not stored in the animal body and is not manufactured (synthesized) in the body. It seems to be manufactured entirely by plants. It has been recently reported that vitamin C has been isolated, crystallized, and analyzed by King and Waugh of Pittsburgh and others, and is said by them to be a hexuronic acid, which functions as a reducing agent during normal metabolism, and is apparently identical with or closely related to the secretion of the adrenal cortex.[1]

The disease known as scurvy (scorbutus), the oldest disease known, is due to deficiency of vitamin C. Maritime history is full of accounts of this disease among sailors and soldiers subsisting upon dried foods, and of its cure by eating fresh foods, notably "limes." Scurvy attacks the gums and tissues of the mouth, also of joints and other structures. The gums become ulcerated, swollen, bleed easily, the teeth decay and may drop out; the individual loses energy and strength, becomes pale and listless and may suffer from headache and nervousness. Extreme cases are now rarely seen, but children frequently suffer from partial deprivation, and may simply show a low and irregular growth curve, anemia, fragile teeth which easily decay, joint pains simulating rheumatism, together with general listlessness and nervous instability.[2] McLester repeats McCollum's story of a preparatory school in which the children were lazy, listless, and backward, and states that there was a startling change following the introduction of fruits and green vegetables in the dietary.

There seems to be a growing conviction among dentists that pyorrhea and dental decay are indirectly caused by vitamin C deficiency, which creates a favorable situation for infections. In treatment of these conditions a pint of orange juice, the juice of one lemon, and half a head of lettuce daily is sometimes prescribed.

[1] Smith, Sibyl L., *op. cit.*, p. 179.

[2] Rose, Mary Swartz, *The Foundations of Nutrition*, p. 267, The Macmillan Company, 1927; Smith, Sybil L., Vitamins in Food Materials, U. S. Department of Agriculture *Circular* 84, November, 1929.

The richest sources of vitamin C are citrus fruits (oranges, limes, lemons, grapefruit), tomatoes, raw cabbage, green pepper, water cress, and leaf lettuce.

Potatoes contain a moderate amount of C but are an important source because of the large amount of potatoes commonly eaten. Most fresh foods contain varying amounts of C. Fresh meat, eaten raw or lightly cooked, has some slight protective value, but meats as usually prepared have no demonstrable protective action. Milk, both human and cow's, has a highly variable vitamin C content, depending directly upon the supply in the daily dietary. Since vitamin C seems not to be stored, milk alone does not provide adequately for the vitamin C quotient.

Sherman calls attention to the fact that resting seeds show no evidence of the presence of vitamin C, but the sprouts of seeds placed in water, to which have been added only air and water, show marked antiscorbutic properties. He says, "It is plain that something preexisting in the seed must have been transformed into vitamin C as the seed sprouts."[1] This suggests an unknown provitamin for vitamin C such as the provitamin carotin for vitamin A and ergosterol for vitamin D.

The pregnant woman will do much to conserve her teeth, digestive vigor, and general well-being if she includes an abundance of vitamin C in her daily diet. The lactating woman and the growing child also should be especially well provided with this factor.

Vitamin D, "Sunshine Vitamin," "Antirachitic Vitamin."— Vitamin D is a fat-soluble vitamin which is synthesized in the animal body by the action of ultra-violet ray from the sun or an artificial ultra-violet lamp upon a sterol in the tissues known as ergosterol. It is also produced in the same manner in plants. Ergosterol is known as the *provitamin* for vitamin D. Vitamin D is heat-stable and is stored in the liver. Vitamin D has been isolated in crystalline form known as *calciferol.*[2]

The function of vitamin D is closely associated with mineral metabolism. As we have seen (page 179), the calcium-phosphorus-magnesium balance is extremely important not only to bone development but also to the structure and function of all

[1] Sherman, *op. cit.*, p. 427.

[2] Smith, Sybil L., *op. cit.*, p. 181.

body tissues. This balance depends upon several factors: (1) The presence of minerals in the diet; (2) the proper functioning of the anterior pituitary, the parathyroids, and probably other of the glands of internal secretion; and (3) the presence of vitamin D. Vitamin D seems rather specifically to control the above mineral balance during fetal life and early infancy.[1]

If there is a deficiency of vitamin D in the diet of the mother the infant is born with a predisposition to rickets. It is only rarely that a child is born with active rickets, but symptoms may appear very soon after birth. It is believed that the antirachitic regimen of the mother during pregnancy and lactation is essential to the protection of the child.[2]

Continued overdosage of vitamin D or overexposure to concentrated ultra-violet rays may cause excessive deposit of minerals in the tissues, or *hypermineralization.* One child was believed to have died from the effect of double dosage with cod-liver oil, which produced lime deposits in the kidneys and other tissues.[3] For further discussion of vitamin D deficiency see chap. XV, Rickets.

Vitamin D may be provided in food previously artificially irradiated by ultra-violet lamp, or in which vitamin D has been formed naturally as in liver oils, butter, egg yolk, and to a more limited extent in green leaves; or it may be created in the mother's own body by the action of direct sunlight or ultra-violet lamp upon the provitamin ergosterol within her own skin. The safest plan is a combination of all of these. It is now advocated that the pregnant woman take sun baths, eat food known to be rich in vitamin D, and in event of any possible deficiency from these sources (which is particularly likely to happen in the winter and to the city dweller), that she take cod-liver oil or viosterol *as prescribed by her physician.* Cod-liver oil is a rich source of both vitamins A and D. Viosterol has been standardized and protected by patent, so that all preparations put out under this name are uniform. This is an exceedingly important thing since viosterol is highly concentrated and powerful and must be used

[1] Hess and Weinstock, The Prenatal Factor in Rickets, *American Journal of the Diseases of Children,* November, 1928.

[2] Rose, *op. cit.,* p. 270.

[3] *Science,* May 26, 1933.

with great care. Overdosage may be very detrimental—especially in any shortage of vitamin B. Viosterol is a highly concentrated form of vitamin D but contains no vitamin A.

Vitamin E, "Antisterility Vitamin."—Fat-soluble vitamin E was first isolated by Evans and Bishop of the University of California. It is stored in various tissues, and it is stable to heat. They found that in the absence of this vitamin the male sperm cells lose motility and finally disappear because of atrophy of the sperm-producing mechanism in the testes. In the female, fertilization and implantation of the ovum may occur with subsequent degeneration and resorption of the placental structures and loss of the fetus.[1] Under this lack, both sexes eventually lose sex interest. Less extreme deficiency may not show in the nutrition of the subject but only in impaired fertility. Dr. Evans reports that vitamin E probably has an important effect upon the growth and vigor as well as upon sex function, since its absence from the diet of the mother produces paralysis in suckling young. Deprivation in the very young seems markedly to affect their nutrition and development.[2] The young of mothers fed a minimal amount of vitamin E may be sterile from the beginning of their sexual maturity.

Vitamin E differs from other vitamins in that it is found in body fat and muscle to a greater extent than in organs, but it is not plentiful in either. Seed oils, particularly wheat-germ oil, are especially rich sources. It is found in green leaves, a very little also in milk, eggs, and cod-liver oil.

Since very little vitamin E is required to maintain normal reproduction, and since there is some vitamin E in most foods, there is little danger of serious lack in any fairly balanced diet.

Vitamin G, B_2, or P-P, "Poor Man's Vitamin," "Pellagra-preventive Vitamin."—This water-soluble vitamin has been separated from "B Complex." It is heat-stable and is probably stored to some extent in muscles and other tissues. Vitamin G is sometimes called the "poor man's vitamin" because it is so

[1] Evans, Burr, and Althansen, The Antisterility Vitamin, Fat Soluble E, *Memoirs of the University of California*, vol. 8.

[2] Evans and Burr, Development of Paralysis in the Suckling Young of Mothers Deprived of Vitamin E, *Journal of Biological Chemistry*, vol. 76, 1928.

commonly lacking in low-cost dietaries, which are apt to show excessive emphasis upon cereals and fat.

Deficiency in vitamin G causes loss of strength and vigor, lethargy, loss of weight, low immunity to infections of eyes and mouth, and specific susceptibility to pellagra, a disease manifesting these symptoms and also a characteristic eruption or skin lesion.

Vitamin G is found in lean meat, milk, liver, eggs, and green leaves. It is low in cereals and fats. Because it accompanies animal proteins there is no danger of deficiency in any balanced diet.

Summary.—From this brief mention of a few of the outstanding factors in animal metabolism it will be apparent that the whole subject of human nutrition is involved and complicated, and amazingly interesting and important. Enough evidence has been presented, it is hoped, to convince the student that the type of dietary called "the balanced diet" has an abundance of scientific justification, and in no sense represents the empirical or arbitrary opinion of physicians or nutritionists. While individual specialists vary in emphasis and detail, and while there remain many unknown and vaguely known items in the metabolic picture, the general consensus sifts down to recommendation of milk, eggs, whole grain, a great variety of vegetables and fruits, and especially the inclusion of a considerable amount of fresh or uncooked food, as constituting the most satisfactory diet for the promotion of growth, physiological function, and extension of life. "The proof of the pudding (the balanced diet) is in the eating." Experience seems entirely to justify the scientific faith in the validity of these recommendations.

The obvious thing for the expectant mother to do is to map out, with the aid of her physician and her reading, a dietary suitable in amount and variety for her particular, individual needs. The next thing is the selection and particularly the quantitative estimation of these foods. Fortunately, it is not necessary to calculate quantities closely, since the normal dietary provides sufficient margins of safety, and the body mechanism provides in a wonder-compelling way for regulation and adjustments between surplus and deficiency in most of the important factors. It is necessary, however, to be able to recognize both

the presence and the relative amount of the necessary food factors. In the Appendix, pages 650–657, are presented tables and descriptions which will enable one to analyze the day's diet with sufficient accuracy for practical purposes.

Things Which Should Be Avoided. *Indigestible Food.*—Almost every one knows that certain foods are hard for her to digest, although others seem to eat them with safety. It is foolish to take chances on upsetting the health during this important period by indulging in such foods.

Warm, soft or fresh breads should be eaten in moderation and not at all if there is any tendency toward indigestion. Thoroughly baked bread, toast, or zwieback, with heavy crusts, is better for the health and teeth.

In general, fried, overcooked, undercooked, greasy, overseasoned, or very rich foods such as pastry, pie, rich puddings; also soda-fountain productions and candies should not be eaten. They overtax the digestive system and give little of value in return.

Manner and Time of Eating.—The pregnant woman should *eat very slowly and chew thoroughly.* This is the best way of preventing gas, "bloating," "water brash," "heartburn," "fullness," and other discomfort. It makes the work of digestion easier and more complete.

Women who suffer from nausea or who find the digestion to be easily upset at this time, or who suffer from a sense of pressure and fullness, do better to eat sparingly at meals and take a light lunch midway between meals with a glass of hot milk and a cracker at bedtime.

In general, the expectant mother should eat regularly even when eating many small meals. The digestive system must have regular rest if it is to function properly. One should not develop the habit of "nibbling all the time," or eating much at one time and little at another. Even during the discomfort of the "morning sickness" one should try to adhere to a fairly regular scheme.

Mental Hygiene and Food.—Especially should a pregnant woman avoid thinking too much about her food and digestive sensations. She should make sure she is pursuing a normal food program, then occupy her mind with other interests and avoid discussion of these subjects with her friends and sympa-

thetic acquaintances. She will find that she feels more normal and enjoys her food the more the less she dwells upon the matter.

Special Diets.—No pregnant woman should undertake to diet herself for the purpose of having an easy childbirth except under definite instructions from her physician. Otherwise she runs a risk of doing serious injury to herself and her child.

Cravings.—Pregnant women sometimes crave pickles or chalk or other curious things to eat. This means that they have not been eating a well-balanced diet; or that some nutritional disorder indicating medical attention is present; usually it means a lack of food rich in minerals and vitamins such as the mother's blood needs in special abundance at this time. The trouble can be corrected by eating freely of fresh vegetables and fruits, especially leafy vegetables, and taking a full supply of milk and milk products, eggs, and cereals. These will supply the essentials, which the baby is taking out of the mother's own tissues, and the loss of which is creating the craving.

Elimination. *Bowels.*—Regular movement of the bowels is essential. One thorough movement per day, usually soon after breakfast, is the general habit among civilized adults, although children and primitive people tend to have a bowel movement after each meal, and occasionally a person is found who eats an easily assimilated diet and seems to thrive with a regular movement at longer than a 24-hour interval.

A regular, well-balanced diet with plenty of roughage; with regular exercise and a generally active life; with rest and sleep enough to maintain muscular and glandular vigor; with corrective exercises for pressure, should insure regular bowel movements and make the taking of cathartics unnecessary. If assistance becomes necessary the doctor should always prescribe as he should not only know the condition but know exactly what his patient is taking.

Kidneys.—The elimination of waste through kidneys and skin is also important. If the woman is having 3 glasses of milk and 5 to 7 of water daily, besides the fluid content of fruit and vegetables and of cooked food, she should void not less than 3½ to 4 pints of urine daily. If at any time there should seem to be a lessening in amount, the urine should be saved for 24 hours (starting with the bladder empty), shaken, and measured,

and the exact amount reported to the doctor, together with a sample for examination.

Skin.—Daily bathing, with vigorous rubbing of the skin and sufficient exercise, will insure active skin elimination. The pregnant woman may continue any form of bathing she has found to be agreeable. Cold baths, vapor sweats, hydro-therapy treatments or any new or extreme experience should never be undertaken without the physician's knowledge and approval. Athletic, active women may usually go on with cold baths, a moderate amount of swimming, hiking, or ordinary sports, not only without danger, but as a necessity in keeping physically fit, both through preserving muscle tone and in promoting active elimination.

Alcohol and Tobacco in Pregnancy.—The present social flair for smoking and drinking raises the important question as to the effects of these habits upon the health and the maternal competency of women. While a good deal is being written upon these subjects, there is a dearth of precise, controlled scientific information as to the effect of these drugs upon normal body function, and still less seems to be known as to the specific effects upon germ cells and maternal function in pregnancy and lactation.

From what has been sketched here it will appear that the chemical unity of the body metabolism is an intricate and delicate affair, and that the intricacy and nicety of balance are accentuated during pregnancy by throwing the metabolic machine of the child into gear with that of the mother.

The habitual introduction of chemical substances which are foreign to the metabolic needs of the body, and which must, even under the most favorable circumstances, impose a burden of accommodation upon the physiological machine of the expectant mother, is a matter which should receive thoughtful consideration.

In general, this statement applies to anything not comprised within the balanced diet here discussed: to the nibbling of sweets, to indulgence in soda-fountain products, to excessive use of tea and coffee, as well as to the habitual use of alcoholic drinks and tobacco. We shall confine our discussion to the last-named substances since the others have been mentioned elsewhere. The

following conservative statements will probably be accepted without question.

1. Each human organism (in common with all other organisms) has its own specific (as well as general) chemical and protoplasmic pattern, with its own dynamic equilibrium[1] or specific range of adaptation and limits of accommodation to unfavorable conditions and foreign substances, including drugs and chemicals having specific effects upon living protoplasm, such as alcohol and nicotine. Within the range of perfect accommodation these foreign substances probably have no effect upon health and function. The body incorporates a regular amount of them into its pattern or plan and goes along with little obvious disturbance, as long as the amount is not increased and the use is regular. The morning cup of coffee, the glass of beer, or the cigarette of the "moderate user" illustrate this.

2. When the range of perfect accommodation is exceeded and symptoms of interference with the metabolic balance of the body are produced, such as impairment of mental and physical coordination in the case of alcohol, or nervousness, tremor, and irregular heart action in the case of tobacco, wakefulness in the case of coffee, *there can be no doubt that functional integrity of the body is impaired.* The degree of injury naturally may range from slight to severe.

3. The capacity for recovery, like the capacity for accommodation, varies from individual to individual, and the two do not necessarily correlate with each other. The body mechanism of one individual may accommodate to an extreme limit, but remain permanently impaired when accommodation is once broken by excess in the form of debauch. Another individual may be susceptible to the effects of drugs such as these under consideration, but show speedy elimination and repeated recovery. There is however, in every human organism a limit to both accommodation and recovery, and every so-called "recovery" probably leaves a weakened mechanism.

4. The habit-forming character of these substances, which may be said to be their essential characteristic, tends to create a craving which subjects the user to the constant danger of exceeding the limits of both accommodation and recovery.

[1] MITCHELL, *op. cit.*, pp. 188–189.

The Effect of Alcohol.—Alcohol has an affinity for nerve tissue; conditions within the nerve cells are modified in such a way that excitability is reduced. By partial paralysis of the vagus (inhibitory nerve), the respiration, heart rate, and oxygen consumption may be temporarily increased because "the brakes are taken off"; this is followed by depression of heart and of respiration, the body is forced to exist upon low rations of food and oxygen, and waste products are not removed at a normal rate.[1] The deadening of the defensive mechanisms of the body creates a sense of well-being which is replaced by apprehensiveness, restlessness, and craving when elimination is complete.

The increase in incidence of errors in performance under the effect of alcohol is well known, as is shown by the prohibition of alcohol to athletes in training, to engineers, and to workers in most industries.

Alcohol passes unchanged into the blood stream, where it is slowly oxidized, requiring from 7½ hours in habitual users to twice this for abstainers.[2]

After moderate ingestion of alcohol minimal quantities are found in milk secretion.[3] Nature safeguards the infant by causing the milk glands to make up the milk formula, so to speak, from what is brought to the glands by the blood stream, and has endowed these glands with highly defensive mechanisms against injurious substances, such as drugs and disease toxins. Nevertheless, this defensive mechanism may be overwhelmed.

It has long been accepted that alcohol is toxic to germ plasm. This is shown by high prenatal and early postnatal mortality when pregnant animals are subjected to its influence. The general effect is to weed out weak germ stock. Several generations after the toxic generation superior resistance and survival may be shown.[4]

On the whole, the pregnant woman would seem to have, for abstaining from the use of alcohol, every reason that obtains

[1] Rising, Mary M., *Chemistry in Medicine*, chap. VIII, The Chemical Foundation, Inc., 1928.

[2] Lusk, *op. cit.*, p. 479.

[3] *Ibid.*, p. 544.

[4] Stockard, C. R., *Physical Basis of Personality*, pp. 159–161, W. W. Norton & Company, Inc., 1931.

in the case of the athlete or mechanic, and it would seem the part of wisdom to avoid ever contracting the habit of its use.

The Effect of Tobacco.—Tobacco contains the powerful narcotic poison nicotine; carbon monoxide is also constantly present in tobacco smoke, together with poisonous aldehydes, ammonia, and irritative oils.[1] Both nicotine and carbon monoxide deaden sensibility, nicotine by direct action upon the nerves, carbon monoxide by displacing the oxygen of the red blood cells in the blood.[2]

There is much more absorption from "inhaling" tobacco smoke than from ordinary smoking. Inhaling tobacco smoke produces disturbances of blood pressure and heart action through injury to their nervous mechanism, and lowers the general resistance to infections, especially to mouth and throat infections.

Nicotine has been proved to lessen the milk secretion in the cat and cow and in at least one human instance. This subject, who is reported by Dr. Hatcher, smoked from 20 to 25 cigarettes daily and showed marked diminution of milk supply from the onset of smoking, with a trace of nicotine in the milk.[3] Here again Nature seems to protect the child, as there are few medical reports of instances of infants showing evidence of nicotine absorption.[4] In the case cited, however, the study was suggested by the observed effect upon the child.

If a pregnant woman is a habitual user of tobacco she should consult her physician as to the necessity or advisability of giving it up or reducing the amount. Above all, she must have the courage to face the situation and not rationalize herself into a conviction that she is experiencing no harmful results.

[1] Smoke Cigarettes Slowly, *Science News Letter*, July 27, 1929.

[2] *What It Costs to Smoke Tobacco*, Leaflet of Life Extension Institute, 25 West 43rd Street, New York City.

[3] Nicotine Affects Milk Secretion, *Science News Letter*, June 15, 1929.

[4] Mendenhall, W. L., *Tobacco*, pp. 44–46, Harvard University Press, 1930; Warring, J. J., The Hygiene of Smoking, *Hygeia*, American Medical Association Press, June, 1925; editorial, *Journal of the American Medical Association*, June 25, 1925; Hull, Clark L., The Influence of Tobacco Smoking upon Mental and Motor Efficiency, *Psychological Monograph* 150, Princeton University Press, 1924.

Minerals in the Diet

Mineral	Increased requirement in pregnancy	Chief functions	Chief sources	Effect of deficiency
Calcium	+++	Bones, teeth, blood, nerves, muscles	Milk and milk products, green vegetables, carrots	Rickets, tetany, nervousness, anemia, poor teeth
Phosphorus	++	Bones, teeth, and all cell nuclei, nerves, protoplasm	Animal protein: meat, milk, eggs, fish, nuts, beans, grains, carrots	Rickets
Potassium		Buffer, concentrates in cells, controls osmosis	Most vegetables, whole grains, potatoes, beans, raisins, fruits	Acidosis
Sodium		Buffer, concentrates in fluids as sodium chloride: controls osmosis	Common salt	Acidosis; disturbance of osmosis and water-balance
Chlorine		Combines with sodium, also forms gastric hydrochloric acid	Common salt	Same as sodium, also digestive disturbance
Sulphur		Enters into proteins, hemoglobin, detoxicating agent	Protein foods	Auto-intoxication
Magnesium		Linked with calcium and phosphorus in bone metabolism, balances calcium-phosphorus metabolism	Most foods, in traces	Tetany, convulsions, nonretention of calcium and phosphorus
Iron	++	Hemoglobin formation	Red meat, egg yolk, green vegetables, whole grains, liver	Anemia
Iodine	+	Growth, reproduction	Water, milk, vegetables, sea foods	Cretinism, goiter, low growth and mentality
Manganese		Reproduction, formation of placenta	Whole cereals, all vegetable foods	Loss of fetus
Copper		Hemoglobin formation	Same as for iron	Anemia
Fluorine		Bones, teeth, enamel—not well known	Milk, vegetable fiber	Too much fluorine in water injures enamel
Silicon		Hair, feathers, lens of eye—not well known	Milk, vegetable fiber	Not known

Vitamins

Characteristics and effects	Vitamin A, "growth and immunity," antixerophthalmia	Vitamin B (B_1, F), "appetite and growth vitamin," anti-beri-beri	Vitamin C, "dental vitamin," antiscorbutic (scurvy)	Vitamin D, "sunshine vitamin," antirachitic	Vitamin E, "reproductive vitamin," antisterility	Vitamin G (B_2, P-P), "poor man's vitamin," pellagra-preventive
Isolated	Yes	No	Yes (hexuronic acid)	Yes	No	No
Water-soluble		x	x			x
Fat-soluble	x			x	x	
Heat-stable.	+	−	−	+	+	+
Stored	Liver	No	No	Liver	Fat, muscle	Muscle(?)
Provitamin.	Carotin, "pigment radical"		?	Ergosterol		
Effects on metabolism and growth.	Specifically affects growth and function of mucous membranes, also general growth, vigor, and longevity	Essential to gastrointestinal function, also to nervous and glandular systems and general growth	Essential to dental calcification, general growth, and energy	Essential to calcium-phosphate balance and bone growth	Essential to growth, vigor	Essential to growth and vigor
Effects on reproduction.	Fertilization and implantation depend on health of reproductive mucosa	Essential to lactation and to general glandular function			Essential to male fertility and to placental formation in female	

VITAMINS.—(*Continued*)

Characteristics and effects	Vitamin A, "growth and immunity," antixerophthalmia	Vitamin B (B_1, F), "appetite and growth vitamin," anti-beri-beri	Vitamin C, "dental vitamin," antiscorbutic (scurvy)	Vitamin D, "sunshine vitamin," antirachitic	Vitamin E, "reproductive vitamin," antisterility	Vitamin G (B_2, P-P), "poor man's vitamin," pellagra-preventive
Effects of deficiency	Lowers the permeability of mucous membranes to respiratory and intestinal infections, causes sterility in male, ovum fails to implant, may cause urinary calculus; all due to impaired membranes, (may have specific immunizing property)	Loss of appetite, intestinal atony, digestive disturbance, colitis, appendicitis, hypertrophy of adrenals, cardiac trouble, arrests growth, arrests ovulation, loss of weight, polyneuritis, beriberi, lowers learning threshold	Anemia, infection of gums and teeth, headache, nervousness, joint pains, loss of strength, digestive disturbance, heart impairment, arrest of growth, scurvy	Rickets, anemia, tetany	Loss of sex-interest, sterility, loss of fetus, sterility in young, impairment of lactation	Loss of strength, infections of eyes and mouth, pellagra with skin lesions, lethargy, loss of weight, arrest of growth
Sources	Yellow and green vegetables; butter fat; egg yolk, liver, cod-liver oil, oranges; destroyed by irradiation	Wheat germ, seed germs and oils, yeast, whole grains or cereals, egg yolk, wheat-germ sugar, and other commercial concentrates	Citrus fruits, tomatoes, raw cabbage, lettuce, turnips, sauer kraut	Cod-liver oil, halibut oil, viosterol, liver oils, sea foods, liver, egg yolk, irradiation, sun baths, irradiated foods	Seed germ, seed oils, green leaves, some in body fat and muscle	Most protein foods; lean meat, eggs, milk, green vegetables

III. EXERCISE

Amount of Exercise.—Exercise is the law of life. Regular activity is absolutely necessary to maintain muscular strength and the tone and vigor of the circulatory system and vital organs. One tends to become toxic or poisoned with one's own waste when confined to bed, or when taking too little exercise.

The expectant mother who does not suffer from some complication which makes exercise dangerous to her should lead an active life and keep herself fit and her muscles strong by regular, well-balanced work and exercise which will use every part of her body. She should not overuse any one part of the body, nor should she overwork.

Kind of Exercise.—General housework affords good, all-round exercise if well planned, and if it can be compassed within a reasonable number of hours. A strong, muscular woman who is accustomed to heavy work may even do washing, ironing, gardening, and other hard work up to the later weeks of pregnancy, always providing she feels no ill effects. Peasant women are sometimes taken in labor while in the fields. Those women who lead vigorous, outdoor lives have notably normal labors.

Work and Exercise Should Be Varied.—A woman should not sew continuously for a week at a time, nor should she clean house nor make garden continuously day after day. She should either give a certain number of hours to each, every day, or she should at least alternate days of sewing with days of vigorous muscular work.

Outdoor Exercise.—A definite and regular amount of outdoor exercise should be taken every day. There is no tonic like fresh outdoor air, and sunshine is now classed as a health essential. The expectant mother owes it to her unborn babe to give him this chance for vigor. This means exercise for pleasure, not long shopping expeditions which produce fatigue rather than exhilaration. Sports which involve violent exertion or excessive reaching, such as tennis, or possibility of sudden hazard, such as swimming in rivers, the sea, or lakes, should be avoided.

Exercise for Women Who Do Not Work.—The woman who does not do her own housework, especially the woman who boards, keeps a maid, or lives in a small apartment, must take

special pains to practice regular exercises, including deep breathing, arm exercises, and bending exercises to strengthen the back and abdominal muscles, and also to take daily walks in the open air.[1] All exercises should be begun rather gently if she has been unaccustomed to doing them. *At no time should violent or jerking exercises be attempted.* Contrary to popular opinion, a moderate amount of stair-climbing is excellent exercise for any woman who is normal and healthy. To go upstairs without fatigue or strain, she should stand erect and proceed as if walking on a level, except for the extra push necessary to hoist the weight of the body from step to step.

Cautions.—A woman will not cause the cord to become wrapped around the baby's neck by reaching over her head. Nature has prevented this by floating the baby in the "bag of waters" and by making the cord so long it cannot be put on tension by anything the mother may do. On the other hand, she may cause miscarriage by overreaching or overstraining in any way. Therefore, she should not reach, lift heavy loads, run, or do anything else to excess. She may, however, sleep with her arms over her head, take dishes from the upper shelf, or *do anything which will not cause a sense of strain.*

Traveling.—A woman may ride moderate distances in carefully driven cars or vehicles over smooth roads, but there is great danger of producing miscarriage through jolting or jarring if she is driven too fast or too far over rough roads. Touring should be avoided, also railroad journeys unless really necessary, because of the enforced interferences with regular habits and the difficulty in securing attention in emergencies.

IV. SLEEP AND REST

The pregnant woman should have an abundance of sleep, always in a comfortable bed and in a room with very fresh air or, better still, on a sleeping porch. *This means going to bed at such a time that she awakens fresh and rested in the morning.* In other words, she should "get her sleep out" every night. There is no danger that a normal person will sleep too much. Recent research in sleep shows that normal movements are hampered

[1] Van Blarcom, Carolyn, *Obstetrical Nursing*, pp. 122–123, 2d ed., The Macmillan Company, 1929.

and that one sleeps less restfully with a bedfellow (see page 351). The pregnant woman will usually rest and sleep better if she sleeps alone.

Rest.—While pregnant a woman should break her day's work with frequent periods of rest. She will accomplish just as much and will be less fatigued at the end of the day. During the first half of pregnancy there is downward pressure, and during the last half there is upward pressure. Both displace the center of gravity and make it fatiguing to stand continuously. If a woman's work is such that she must "be on her feet" a great deal, it is especially important that she drop down flat on her back on a bed or couch, or even on the floor, with her feet upon a cushion or small box or foot of the bed, for five minutes every hour or two during her work day. This will do much to prevent varicose veins and swollen feet and legs, and will bring her through the day with much less fatigue (see page 227).

If her rest is unavoidably broken by young children, or if she must get up early and does not go to sleep readily at night, she must plan to take a nap after the noon meal. If she has other children she can often do this by lying down while the toddler takes his nap.

It should be a matter of conscience with the expectant mother not to let herself become too tired or to lose sleep. Fatigue and loss of sleep poison the blood just as definitely as do disease or bad food. A good test is the way one feels in the morning. If she feels fresh and vigorous and ready for a new day she has not overtaxed herself on the previous day. If she feels languid, dull, or tired in the morning something is wrong; it may be her work, her sleeping regime, or her metabolism which is at fault, or all three. She should try very earnestly to discover and correct the cause.

V. MENTAL HYGIENE AND RECREATION

It is now known that emotion has a profound effect upon metabolism. While an expectant mother cannot "mark" her child, she may profoundly affect his well-being and her own by her mental and emotional attitude or experience. Bearing a child is the supreme experience in human life. Then, if ever,

should a woman be serene, poised, and so uplifted that she does not react intensely to the petty frictions of life.

It is also known that body chemistry has much to do with one's emotional reactions and attitudes. It is much easier to be patient and serene if one is well fed and rested than when fatigued and undernourished. One can strive for a sane philosophy, not in order to produce a child prodigy, but in order to prepare for the child a mother who will be an inspiring and understanding companion.

For the same reason the expectant mother should discipline herself in self-control and courtesy, and never take advantage of "her condition" to indulge herself in selfish, complaining, egoistic attitudes toward her family and others.

The pregnant woman should dress becomingly, groom herself attractively, and enjoy her customary social relationships, always short of excitement or fatigue. She should keep herself mentally normal.

VI. CARE OF THE PERSON

Bathing.—A daily morning sponge bath, shower, or quick plunge in a tub, followed by energetic friction with a rough towel is most refreshing, stimulates the circulation, improves the appetite, and makes one less liable to take cold. The temperature of the water should be agreeable to the individual; tepid to cold is preferable. It is the wetting and the rubbing which do the work of seasoning and stimulating the skin. In addition to the morning rub, a warm soap scrub should be taken twice or oftener during the week, preferably at bedtime. It improves the complexion, even the mind is more cheerful, if one has a fastidious sense of bodily cleanliness and freshness.

Care of the Teeth.—The teeth should be carefully brushed at least twice daily, using unsweetened powder or paste or milk of magnesia, in order to counteract the tendency to acidity which is often present during pregnancy. As has been said, the teeth of the expectant mother should be under the observation of a dentist for the entire duration of pregnancy.

Care of the Breasts.—During the last two months of pregnancy special attention should be given daily to the thorough bathing of the nipples with soap and hot water, using a moderately stiff

nail or flesh brush or Turkish washcloth. This may be followed with cold application and massage. If the nipple is very small or inverted it should be pulled out and shaped and rubbed in order that the baby may more conveniently grasp it. A breast pump may be used to draw out the nipple. A large-mouthed bottle such as a milk bottle may be rinsed with hot water and applied quickly over the nipple. The cooling of the air inside the bottle will cause suction upon the retracted tissues. Or an electric vacuum cup may be applied.

Care of the Abdomen.—The skin of the abdomen becomes stretched during the later stages of pregnancy, and sometimes breaks into striae or scars, which remain as a disfigurement. In some cases the muscles remain lax and soft after delivery, and it is said that the woman has "lost her shape." Something can be done to prevent both these effects of stretching by rubbing the abdomen every evening after retiring, or every day after the bath, with cocoa butter or cold cream or other lubricant, but the effect is probably chiefly due to the rubbing. There is no virtue in the much-advertised applications for causing easy labor. If the muscles are greatly overstretched a well-fitted muslin binder worn during the last month or six weeks of pregnancy will take some of the strain from these muscles.[1]

Marital Relations during Pregnancy.—There is no accurate information as to the effect of sexual intercourse during pregnancy, but there seems to be a growing tendency on the part of obstetricians to advise against the practice.[2] Certainly it should be indulged in moderately and only at the desire of the woman, and should never be forced upon her. DeLee says that coitus during pregnancy, particularly during the first three and the last three months, is likely to produce abortion. He states that it aggravates all complications and may cause septic poisoning.[3]

VII. CLOTHING

Clothing for the Mother.—There is no need for an expectant mother to make any radical change in style or material from her

[1] DeLee, *op. cit.*, p. 244.

[2] *Prenatal Care*, U. S. Department of Labor, Children's Bureau, Washington, D. C., 1931.

[3] DeLee, *op. cit.*, p. 240.

usual apparel. Most pattern manufacturers now issue patterns for maternity gowns which closely follow current styles. There are firms which specialize in the designing and manufacture of maternity gowns. It is no longer necessary for a pregnant woman to appear grotesque or to feel embarrassed on account of her appearance.

Underwear should be loose, and bloomer bands, garters, etc., should be nonconstricting. Unless well-fitting suspender supports can be achieved, it is better to wear "rolled" stockings or very loose round garters. The stockings should never be suspended from belt supports about the waist. Suspender supporters need to be well adjusted to the form, or the "pull" becomes annoying and causes discomfort.

At the present time shoes are the item of clothing most likely to interfere with comfort and freedom. Because of the probability of some swelling of the feet, shoes need to be larger than those ordinarily worn. Because of the shifting of gravity as pregnancy advances, shoes should have broad low heels to make walking erect as easy and safe as possible. Sport or business shoes or orthopedic or foot-form lasts should be selected. A pregnant woman should never change to high heeled party shoes even for special occasions, as falls and muscle strain may very easily result.

Stiff corsets are fortunately going "out of style," and it is now scarcely necessary to discuss maternity corsets. These should certainly never be worn for appearance. No woman could be vain and selfish enough to impair the well-being of her unborn babe by the constriction of her circulation and of the activity of her child. Nature has omitted the ribs from the abdomen and replaced them by a remarkable arrangement of abdominal muscles which should have been trained and developed in the growing girl for their very important service in child-bearing.

Sometimes, unfortunately, a woman has such poor abdominal muscles and bad posture that she cannot comfortably carry her child without the assistance of an abdominal support. A properly adjusted cloth binder is better than even a well-fitted corset, as it restricts movement and circulation less. A simple strip of heavy muslin may be fitted by pinching up darts with safety pins. If necessary narrower strips of muslin may be

pinned to the binder in the back, crossed, suspender-wise, brought over the shoulders, and again pinned in front to prevent wrinkling and to secure the necessary upward support.

Sometimes during the last months of pregnancy the breasts become heavy enough to cause discomfort. A support for these can also be improvised by passing a strip of soft cloth about a foot wide around the body, crossing in the center in front with a one-loop tie, the ends being brought over the shoulders and pinned to the back of the binder as shoulder straps. If properly adjusted there is upward support without pressure upon the nipple.

VIII. CLOTHING FOR THE BABY

The infant's first outfit may be simple and inexpensive, or may cost a small fortune, according to the inclination and resources of the parents. In neither case should the helpless infant be made an object for display. Everything should be planned for his comfort and well-being alone.

All garments should be simple in style, no matter whether made of fine or coarse material, and should be easily washed and ironed. Maternal love can find expression in fine material and fine needlework if one can command these. It is a mistake for an expectant mother to spend hours of her own time in elaborate needlework when she would do a far greater service to her child by spending at least a part of this time in the open sunshine.

The number of pieces necessary will depend upon the frequency with which laundry work may be done. The following list assumes that diapers and underwear may be washed frequently, daily if necessary, while the outside slips requiring more careful ironing may be washed once or twice a week:

1. Three abdominal bands torn from fine, firm flannel and not hemmed. A half yard of 22-inch flannel may have the selvages torn off, then be torn in three strips.

2. Three shirts which may be bought or made. These should be silk, silk and wool, or wool and cotton; or if for a summer baby may be of cotton. If bought, the No. 2 size is more practical than size No. 1. The shirts should be large enough to allow for growth of the baby and for some shrinkage of material.

3. Three nightgowns of outing flannel, wool flannel, or cotton or wool jersey.

4. Three dozen diapers of bird's-eye cotton, 20 or 22 inches wide, torn in lengths double the width and hemmed by hand or picoted to avoid the stiffness on the edges. These should be laundered before using. A very practical diaper of tubular jersey, which is soft, absorptive, and easily laundered, is now on the market. Because of the ease with which these may be washed fewer are required.

5. Eight dresses of nainsook or Persian lawn or dimity with no trimming on the edge of neck or sleeves.

6. The first cloak. This may be a sleeveless square fastened down the front and having a circle for the neck, to which a hood of the same material may be attached. It may be of eiderdown lined with silk, and it may later be refashioned into the first short coat.

7. Three pairs of soft merino stockings. These should be large enough to allow generously for growth and shrinkage. Stockings having reinforced tabs for pinning to the diaper are to be preferred. Muslin tabs may be added, however.

8. Carriage blankets according to taste and climate.

9. A couple of flannel nightingales or crocheted jackets are useful in meeting sudden changes of temperature.

10. Three knitted bands should replace the flannel bands as soon as the cord is fully healed.

The Style and Manner of Making. *The Telescope Layette.*—These patterns were designed by Dr. Josephine Baker, formerly chief of the Division of Child Hygiene of New York City. This layette is designed so that the garments all open down the front and telescope with each other. After the infant is bathed and has had band and diaper adjusted, it may be laid in the telescoped outfit, which may then be buttoned at leisure without further turning the child. The sleeves of this outfit are sewed in. There is a good deal to be said for the kimono style of garment because of the absence of arm seams and the ease of making and laundrying.

The Wisconsin Layette.—The Child Hygiene Division of the Wisconsin State Board of Health has designed a telescoping outfit with kimono sleeves and neck darts which appears quite ideal. The darts permit easy adaptation to the growth of the

child, as by ripping these one may keep the child wearing his baby clothes until they are worn out.

In general, the neck and sleeves should be finished with soft hems or drawstring casings only. Any kind of trimming about

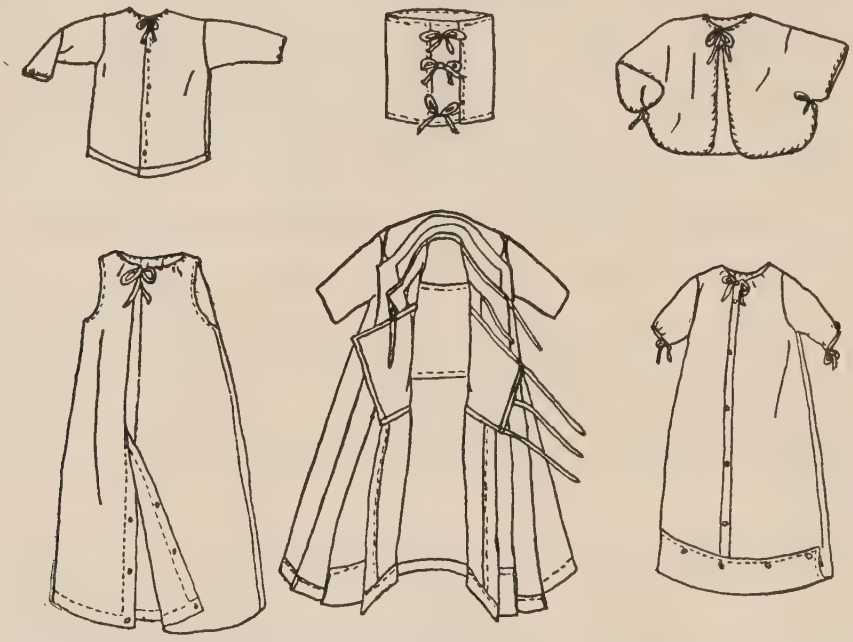


FIG. 42.—Telescoping garments: sewed-in sleeves. Designed by Dr. Josephine Baker, Bureau of Child Hygiene, Department of Health, New York City.

an infant's neck is out of place. An infant's head is set squarely upon his shoulders; there is no room for lace—it only irritates

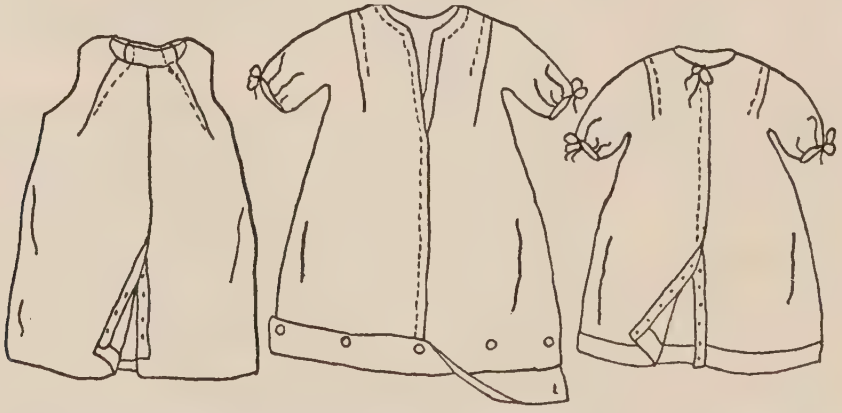


FIG. 43.—Front opening: kimono sleeves. Designed by Gertrude S. Hasbrouck, Bureau of Child Welfare, Wisconsin State Board of Health.

the tender skin, and is swallowed from sight under his (we hope) plump chin.

A nonwrinklable tape may be used to adjust garments at neck and wrist. The closing may be by buttons, snaps, or tying tape as indicated by time and preference. While the front, full-

length closing simplifies the process of dressing the baby, it does increase the labor of making.

Shirts and nightdresses, if made at home, should have seams on the outside in order to present a smooth surface to the delicate skin of the baby. Such seams look very well when neatly featherstitched on the right side.

All garments are now made much shorter than formerly. Twenty inches is customary, except for nightgowns, which

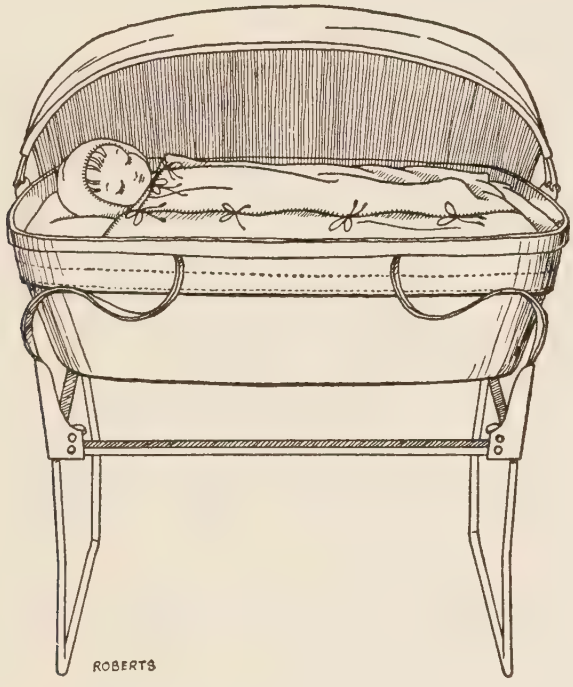


FIG. 44.—The first cloak. Also one type of folding bassinet suitable for auto travel. The side canopy protects child from dust and sun. The springs protect from jolting.

should be made quite long with a flap to button or snap, or a drawstring in the hem, in order to make certain that the child's feet will remain covered at night.

The cost of trimming had better be put into fine, soft material. A simple embroidered monogram is in better taste than tucks and frills.

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CHAPTER XII

COMMON DISORDERS OF THE PELVIC ORGANS WHICH MAY AFFECT REPRODUCTION

A Woman

She had an understanding with the years;
For always in her eyes there was a light
As though she kept a secret none might guess—
Some confidence that Time had made her heart.
So calmly did she bear the weight of pain,
With such serenity accept the joy,
It seemed she had a mother love for life,
And all the days were children at her breast.

SCUDDER MIDDLETON.

Infection.—Soreness or tenderness in the abdomen between menstrual periods should always be referred to a physician. The right ovary sometimes becomes infected from an infected appendix. Pain or tenderness in either side may mean infected Fallopian tubes. Any condition of this kind calls for treatment. Neglect may lead to sterility or invalidism. The passage in the Fallopian tube through which the ovum must travel on its way to meet the sperm is very small; the scar tissue from even a slight infection of a tube may permanently close this passage and *make the union of two germ cells impossible.* The same thing may occur in the spermatic duct of the male. If both tubes or ducts are closed the individual is rendered sterile.[1]

Displacements. *Cause.*—The uterus or ovaries may become acutely displaced by a fall or other accident. Most commonly displacements are caused by bad posture, general lack of muscle tone, and habitual constipation in sedentary women. Child-

[1] Surgical sterilization consists in "tying off" these tubes in either the female or the male, thus making fertilization mechanically impossible. Closing the tubes does not affect glandular function or sexual experience. Complete surgical removal of the ovaries or testes seriously disturbs glandular balance and is done only for the removal of malignant growths or because of other pathological necessity. After menopause the effect of removal is less pronounced.

bearing women who have unrepaired tears of the perineum or who suffer from subinvolution of the uterus are especially liable to have displacements. Displacements may be forward or backward, or simply a falling or lowering of these organs. The most common type is the backward displacement.

Symptoms.—Often no apparent inconvenience is experienced. A marked displacement may be the cause of sterility because the passageway is thereby closed to the spermatic fluid. Sometimes acute pain is experienced, sometimes heavy dragging or aching sensations. Backache may or may not be present. Painful menstruation may follow acute displacement. Headache in the top of the head may be a symptom. Backward displacement may cause constipation through pressure upon the rectum.

Treatment.—An acute displacement can sometimes be corrected by taking the knee-chest position (Fig. 45) every night, faithfully, for some time, together with the Mosher exercise every morning (Fig. 46). If this does not give relief, a physician should be consulted. In all cases the fundamental thing is building up the general health. If good muscle tone can be restored a good many cases recover spontaneously.

Syphilis and Gonorrhea.—Syphilis and gonorrhea are the so-called "venereal" diseases. They are usually contracted directly or indirectly through sexual intercourse with prostitutes. They may, however, be innocently contracted through kissing, through drinking after infected persons, from public toilets, chains or handles of the various types of toilet flush, public towels, etc. This rarely occurs, fortunately, since these germs die very quickly on exposure to light and air. However, everyone should be extremely careful to avoid touching anything which may have recently been contaminated.

Gonorrhea is the more common of the two diseases. Since it often makes both men and women sterile by causing inflammation of the tubes and ducts it is sometimes called "the great sterilizer" (see page 93). Through infection of the baby's eyes while the child is passing through the birth canal, it may cause blindness. For this reason doctors and midwives in most states are required to put prophylactic drops in every baby's eyes soon after it is born. One drop of a 1 per cent solution of silver nitrate or other silver salt is commonly used. From one-fourth to one-third

of all blindness was formerly caused by gonorrhea in the newborn. Because of the increasing use and effectiveness of prophy-



FIG. 45.—The knee-chest position. (*From Handbook on Positive Health, by permission of the Foundation for Positive Health.*)

lactic measures at birth this percentage has steadily declined until, according to recent institutional statistics, it is now only

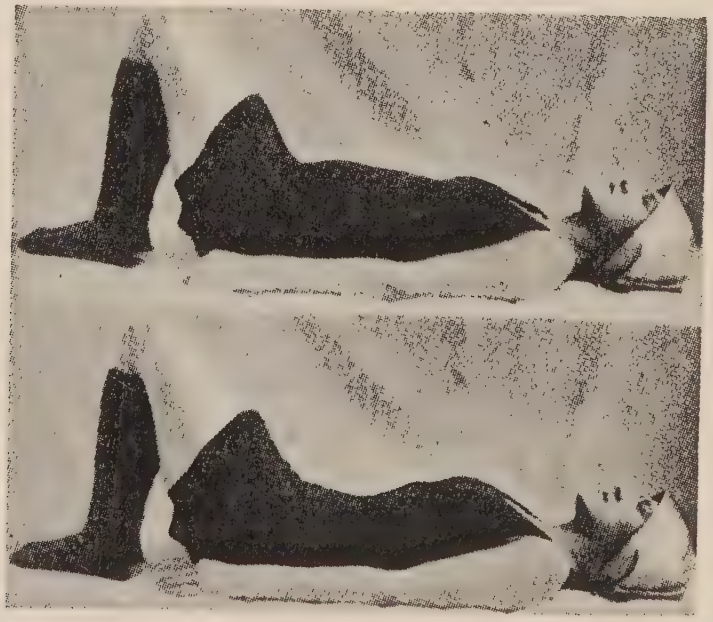


FIG. 46.—The Mosher exercise. (*From Handbook on Positive Health, by permission of the Foundation for Positive Health.*)

4 to 9 per cent.[1] This infection is called *gonorrheal ophthalmia neonatorum*, or "the sore eyes of the new-born"; it develops within 3 or 4 days after birth in untreated cases, and always

[1] ROYER, FRANKLIN, Syphilis and Gonorrhea as Causes of Blindness, *Journal of Social Hygiene*, March, 1931.

destroys sight unless promptly and skillfully treated. Gonorrhea is rarely congenital (present as an active infection at birth), and it is not hereditary.

Gonorrhea is very often transmitted from the husband to the new wife. Infection of the tubes and ovaries may result, and often an operation becomes necessary. Some surgeons say gonorrheal infection of the tubes is the commonest cause bringing woman to the operating table. No person with an active gonorrheal infection should marry. It is possible to cure gonorrhea but it takes a long time and very persistent treatment. Men may become careless or assume that they are cured before they really are, or put their faith in false "sure cures." In both sexes the germs may remain alive but inactive for variable intervals after all symptoms disappear. Therefore a careful examination is necessary to determine fitness to marry.

Syphilis.—The "great slayer of the unborn" is the cause of many stillbirths (babies dead when born), many miscarriages, and also many congenitally defective children (defective when born). It produces many cases of blindness both at birth and during childhood in untreated cases.[1] The fetus may become infected in the uterus if the mother is actively syphilitic, in which case it will be born with active syphilitic germs in its body. This is *congenital, not hereditary* syphilis. Syphilis is sometimes said to be hereditary but this is not strictly true.

The toxins of syphilis in the blood of an infected mother or father may actually injure parts of the germ cells before or after fertilization, and the child which develops from such an ovum will be a defective child, but may not have an active infection; or he may be both defective and diseased. Often, as has been said, the fetus dies before arriving at full development. In rare cases it is possible that the sex chromosomes of the fertilized injured ovum may also be injured and defects accordingly may appear in the "third and fourth generation." To be strictly "hereditary," syphilis would have to produce mutations in particular genes or gene groups (see chap. III). This probably seldom or never occurs.

The modern method of treating syphilis during pregnancy and infancy is highly effective, if the condition in the mother is dis-

[1] ROYER, *op. cit.*

covered in time. It is for this reason that many maternity hospitals and many obstetricians require all pregnant women coming under their care to have a diagnostic examination, including a Wasserman test.

Every man and every woman applying for a marriage license should be required to show a physician's certificate of freedom from communicable or hereditary disease; or better still, an official medical examiner should determine the fitness to marry of all candidates for marriage.

Common Disorders and Complications of Pregnancy.—The majority of pregnancies are free from complications or pathology, and there are many more normal, fairly painless deliveries than is commonly supposed. Forewarned is forearmed, however, and one can successfully avoid danger only by being aware of it and intelligent as to the best method of meeting the various possible hazards of childbearing.

The Toxemias of Pregnancy.—Toxin is a general term denoting a chemical poison, and in this connection toxemia is used to refer to toxic alterations in the physiological chemistry of the body caused by disease processes, either infective or metabolic.

The grafting of an animal parasite (the embryo), with its foreign proteins, endocrine system, placental rootlets, etc., upon the maternal structure necessarily involves rather radical physiological adjustment on the part of the host (the mother). Nature usually takes care of this so fully that the expectant mother has in general, at least up to the later weeks of pregnancy, only a sense of increased vigor and well-being. Many women say "I never feel so well as when I am carrying a child." One little immigrant woman interviewed by an agent of the Children's Bureau of the U. S. Department of Labor declared, "I was happy like a bird, I feel I could fly." DeLee says "the woman may enjoy a permanent improvement in health from the stimulus of pregnancy."[1] In a certain number of cases, however, more or less disturbance of body chemistry occurs.

Since biological chemistry is itself a relatively new science with such sentences as "the chemical changes involved in this process are not yet fully understood" occurring many times in

[1] DeLee, Joseph, *Principles and Practice of Obstetrics*, p. 112, 5th ed., W. B. Saunders Company, 1930.

every text, we are compelled to say that many of the actual chemical changes in the toxemias of pregnancy are only vaguely known. Certain facts, however, are sufficiently established to serve as guides to hygienic conduct.

Uremic Poisoning, "Eclampsia," "Albuminuria," "Bright's Disease," "Nephritis," "Uremia."—The toxemia of pregnancy most often fatal to mother and child is uremic poisoning. While the protein metabolism (see page 165) is closely involved in this, many points as to the exact chemical process are still obscure.[1] There may be an interference with the normal deaminization of the proteins in the tissues and in the liver; there may be an inability of the kidneys to eliminate the uric acid, purin, and other toxic products of the proteins which are normally broken down, or there may be an overwhelming of the intricate mechanism of the liver which is involved in maintaining most of the metabolic "balances" of the body, as seen in the discussion of diet. These conditions also involve interference with the glycogen-regulating function of the liver which, whether as cause or effect, leads to acidosis.[2] Acidosis may lead to water retention (dropsy) and upset the equilibrium between the sodium and calcium ions.[3] A chain of toxic symptoms may result from any of these causes which should lead a woman to consult her physician at once.

The earliest symptoms will usually be detected by the physician himself if he is carrying out a correct program of prenatal care. Interference with the normal catabolism or breaking down of proteins *leads to the appearance of protein in the form of albumin in the urine, and is usually accompanied by a rise in blood pressure.* In some degree these phenomena usually precede definite subjective symptoms. The symptoms noted by the woman herself may be any or all of the following: tired, dull feeling; headache; sharp pain in stomach; floating specks or flashes of light before the eyes, sometimes sudden blindness; dizziness; ringing in the ears; puffiness around eyes; boggy swelling (edema or dropsy)

[1] *Ibid.*, p. 379.

[2] Leventhal, M. L., Diet in Pregnancy, *Journal of the American Dietetics Association*, June, 1931.

[3] Stieglitz, E. J., *Chemistry in Medicine*, p. 536, Water Balance and the Kidneys, The Chemical Foundation, Inc., 1928.

of the feet and hands, due to osmotic imbalance. Later there may be diminished urine, extreme nervousness, or inclination to drowsiness or stupor.

At almost any stage the toxemia may become acute and the woman may go into convulsions (eclampsia). Forced delivery of the child is usually performed at once. If the child has reached the age of viability (seven months or later) and if the mother's condition has not become too acute, mother and child may live. The mortality rate for both mothers and children is high.

In taking the initial history it is important that the doctor should learn whether his patient has had scarlet fever, or other acute infection, such as frequently leaves the organs of metabolism more or less impaired, or whether she has ever had nephritis (Bright's disease) or any other condition which may leave a hidden weakness in her metabolic machinery. Since uremic toxemia in one pregnancy is likely to leave the kidneys less efficient than formerly, the metabolism should be very carefully watched during subsequent pregnancies.

Prevention consists in intelligent diet, rest, and exercise with early and watchful medical care, *especially regular urine analysis and blood-pressure reading.*

Uremic toxemia tends to occur during the last half of pregnancy when the woman is eating more, exercising less, and eliminating through her own body the waste from a rapidly growing child. This is the reason the urine is examined oftener as pregnancy advances.

The Nausea and Vomiting of Pregnancy (Morning Sickness).— This is a toxemia rather than a digestive disorder. This term is applied to a curious tendency of the stomach to reject food after eating although there is commonly no aversion to food, and the woman may eat with relish a few minutes after vomiting. This experience occurs in about one-third to one-half of all pregnancies. It may exist in any degree from occasional slight sensations of nausea especially with the first food taken in the morning (hence "morning sickness"), to extreme inability to retain food. When the condition becomes persistent and continuous it is called "pernicious vomiting."

The cause has not been definitely established. The condition is supposed by some to be caused by the absorption of substances,

possibly proteins, from the newly forming placenta, by others to be of endocrine origin, and by still others to be due to faulty carbohydrate metabolism.[1] This phenomenon usually occurs during the period of active formation of the placenta and tends to disappear entirely by the fourth month of pregnancy.

Although certain drugs seem occasionally to give relief, there is no known authentic remedy. Some women seem to obtain temporary relief by chewing something pungent, such as preserved ginger or soda mint, after eating food. Mild cases can often be fairly well controlled by taking a small cup of black coffee, or other hot drink, with a bit of dry toast, some time before rising. Some women feel better and retain more nourishment if they eat many small meals and no large ones. The woman should try to keep up her strength by eating easily digested food such as peptonized milk, junket, buttermilk, jellied eggs, fruit juices, and vegetable extracts. Some specialists, assuming that carbohydrate deficiency is involved, advise the use of concentrated carbohydrate foods in dry or solid form, such as ice cream, crackers, potatoes, cereals, macaroni, in small amounts every 2 hours.[2]

In general, little harm seems to result from the experience, and the discomfort can be philosophically ignored to a considerable extent. "Taking the matter seriously" aggravates the condition. Nervous women and women who worry about the fact of pregnancy are more liable to have this experience and to have it in an extreme degree. A primipara (a woman having her first child) is more apt to have morning sickness than a multipara (a woman who has borne children). Working women, who "do not have time to pay attention to their feelings," seem to suffer the least.[3]

Salivation.—The secretion of too much saliva is occasionally a complication of pregnancy, and may last for the entire 9 months. Generally it lasts for about the same period as morning sickness and is also regarded as an obscure toxemia. There is little to be done except to keep in perfect physical condition, and

[1] Proceedings of White House Conference, Section on Medical Care, Committee on Prenatal and Maternal Care, *U. S. Daily Supplement*, Dec. 6, 1930.

[2] LEVENTHAL, *op. cit.*

[3] DELEE, *op. cit.*, pp. 110, 267, 370.

spend as much time in the open air as possible. Going on milk diet for a few days and rinsing the mouth with water in which a little alum or other astringent has been dissolved may help to relieve this condition.

Digestive Disorders.—*Increased acidity* of the gastric contents may cause regurgitation of acid fluid after eating. This is variously called "water brash," "heart burn," etc. All bread should be toasted or well dried and eaten very slowly. Greasy food is apt to disagree, especially fried food. Eating very slowly and chewing with great thoroughness will minimize this discomfort. Frequent eating in small amounts usually creates less discomfort than the regular full meals.

Flatulence (Gas in the Bowel).—Bacterial action normally creates fermentation and gas in the bowel. During health gas does not accumulate in sufficient amount to be noticed. Pregnancy may cause retention because of pressure and shift of organic relationship of the abdominal contents, or because of constipation, and may also cause increased bacterial activity. The fermentation of sugars when taken in excess in sweets and pastries, and the eating of greasy or fried foods, or any food of slow or difficult digestion, is likely to cause or aggravate this difficulty.

Treatment consists in correcting constipation, selecting foods with extreme care, careful mastication with a full amount of exercise to encourage peristalsis, and the improvement of general tone and vigor. Lactic acid bacilli tend to antagonize the gas-forming bacteria, therefore buttermilk, natural or artificial, or the Bulgarian bacillus tablets, or the use of sauer-kraut juice, which has a high lactic acid content, is sometimes recommended.

Pressure Complications.—Large blood vessels and nerves come down the spine, branch, traverse the pelvis, pass through the inguinal rings (see page 94), and supply the lower extremities. All blood in the lower extremities must flow through the veins "up hill" and against gravity in order to reach the heart. When the growing fetus, because of bad posture or poor muscle tone in the mother, presses upon these veins and nerves, certain "complications" may result.

Varicose Veins.—The pressure of the developing child upon the large veins in the pelvis through which the blood must pass

from the extremities to the heart sometimes causes engorgement of the superficial veins of the legs and thighs. The pull of gravity aggravates this; hence the condition is worse in the evening than in the morning. Taking the knee-chest position every night (see Fig. 45), sleeping "on the face" as long as this is comfortable, sitting with the feet upon another chair, or lying with the feet or hips upon a pillow, gentle massage of the limbs, stockings supported from the shoulders, all help to make it as easy as possible for the venous blood to get back to the heart. Bandaging with roller bandages of muslin, elastic, or flannel, or with adhesive bandages, will give some relief when the veins become very large. Wearing a well-fitted abdominal support will also help this condition.

A woman who always stands correctly and has good muscle tone and good circulation is not apt to have this complication.

Swelling of the feet is caused by the same pressure in the pelvis which produces varicose veins. Instead of the veins enlarging, fluid leaks into the tissues and causes a dropsy-like appearance. The physician should be told at once of the appearance of this symptom, as it may be a forerunner of uremic poisoning instead of being caused solely by pressure. The same things may be tried for relief as are described above for varicose veins.

Hemorrhoids (*piles*) are caused from the same pressure which causes varicose veins and swollen feet. They are literally *varicose veins in the rectum*, which is a highly vascular, sensitive organ. Treatment by a physician should always be obtained if possible. The bowels must be kept especially open and free, and enemas of soapsuds or oil used to make the bowel movements easy. Carbolated vaseline, zinc-oxide ointment, or any simple healing salve will tend to allay the irritation. Relief from pressure should be obtained by use of the corrective exercises indicated above. Constipation and continued sitting aggravate the condition.

Muscle Cramps.—Some women suffer from violent cramps of the muscles of the limbs during the later months of pregnancy. This is caused chiefly by pressure on the large nerves of the pelvis, which lie side by side with the blood-vessel trunks. Toxemia may also sometimes play a part. Women who have bad posture and relaxed abdomens and who are on their feet a great deal are

especially liable to suffer from muscle cramps. When the cramp occurs, vigorous rubbing, or rather kneading the muscles over the bones with the palm of the hand, as one mixes bread, will give the quickest relief. If a woman is subject to cramps after going to bed she may help prevent these by taking a hot foot bath and rubbing the muscles well before retiring.

Constipation.—Any tendency toward constipation is aggravated by pressure of the enlarging uterus upon the bowel. Corrective exercises and careful diet will minimize this tendency. The attending physician should prescribe all laxatives used.

Frequent urination results from pressure upon the bladder, also from congestion of the urethral membrane. The bladder will not contain the usual amount of urine; hence more frequent emptying is necessary.

In general, any tendency to pressure complications should be promptly treated. Special attention should be given to all aspects of daily hygiene. The woman should take the Mosher exercise in the morning and the knee-chest exercise at night (see page 220), *always with the knowledge and approval of her physician.* If it is necessary for her to work hard or to be on her feet a good deal she should form the habit early in her pregnancy of lying down with her feet elevated for a few minutes every time the clock strikes during her working day. She will get just as much done and will come through her day with less fatigue and pressure discomfort because of this simple procedure.

Local Disturbance. *Leucorrhea.*—There is an unusual amount of mucous discharge during the first and last months of pregnancy, caused partly by pelvic pressure and partly by the general speeding up of all secretory processes. When not excessive this serves to keep the vaginal cavity clean and sterile. There is nothing to be done except to keep the parts very clean by bathing with soap or soda water. If the discharge becomes very great, or becomes yellow or green or odorous, the physician should be consulted, as it may indicate an infection which should be promptly treated.

Pruritis.—Itching of the external parts is sometimes annoying. It is apt to occur in women who are nervous and who suffer from insomnia. Excessive leucorrhea may also cause itching. Anything which improves the general condition will act favorably

upon this. Local applications of soda water, carbolized vaseline, menthol, or peppermint water will give temporary relief. Bathing the parts frequently with cold water will also relieve.

Bleeding during Pregnancy.—Bleeding during pregnancy always indicates that something is wrong and should be promptly reported to the physician. It may indicate that miscarriage is about to occur, or that the afterbirth has grown in the wrong place (placenta previa, see page 145). A slight bleeding may result in very serious hemorrhage. The woman should go to bed and keep strictly off her feet until her physician has seen her. No one should neglect this, thinking she is menstruating even though pregnant, as it is doubtful if this ever occurs.

Miscarriage, Abortion, and Premature Birth.—The terms miscarriage and abortion are both used to apply to the loss of a child before the seventh month of intrauterine life; miscarriage applying to the premature loss of an embryo, abortion to the loss of a fetus (see page 150). As a matter of fact, both terms are used by both laity and physicians to designate any premature loss of the product of conception. After the seventh month a child, though born prematurely, may live under favorable conditions. If born between the seventh month and full term it is said to be a premature birth, or if born dead, a stillbirth.

Miscarriage is especially likely to occur during the second and third months of pregnancy, because the placenta (afterbirth) is not firmly attached to the uterine wall until toward the fourth month.

During this period miscarriage is especially likely to occur at what would be the regular menstrual periods. For this reason a pregnant woman should mark these periods on a calendar and remember to be particularly careful not to overexert or become too tired, nor to have marital relations at these times.

Causes.—Anything which loosens the attachment of the placenta to the uterus may cause premature loss of the embryo or fetus. Causes may be *mechanical* or *chemical.* Mechanical separation may be brought about by anything which produces a sudden or forcible contraction of the uterine muscles. A fall, a shock, a fright, heavy lifting, overexertion, particularly sudden exertion, sexual intercourse—any of these may cause this unfortunate accident.

Chemical causes may be classified as:

1. Toxins produced in the mother's body by diseases, such as smallpox, influenza, and syphilis. Indeed, syphilis is one of the chief causes of premature loss of the fetus (see page 221). Children's contagions are sometimes brought home to the pregnant mother by the school children, and she may thereby forfeit the life of her unborn child.

2. Chemicals may be taken into the body. Drugs, such as cathartics, may cause contractions of the uterus when the bowels "gripe," and thus cause miscarriage. There are certain drugs which are used with criminal intent to produce this effect, all of which are very dangerous.

3. Diet lacking in vitamins or minerals such as vitamin E and manganese may cause premature loss of the child although there is small likelihood of shortage of these in any ordinary diet.

4. Imbalance in internal secretions, particularly failure of corpus luteum and placenta to inhibit the pituitary, or deficiency in the female sex hormone, is also a possible cause.

Symptoms of Miscarriage.—Bleeding is usually the first symptom of threatened miscarriage. This is caused by the loosening of some of the "villi" or "rootlets" which attach the placenta to the walls of the uterus (see pages 147–149). A little oozing may accumulate behind the placenta and finally force the whole mass loose.

Women have been known to go to physicians for medicine to relieve constipation or backache or "bladder trouble" and not say that they were pregnant, or that they at least suspected that they were. This is taking a risk and is an injustice to both the woman and the physician. Any doctor or dentist consulted by a pregnant woman should be told of her condition.

If bleeding progresses to the point that the uterus begins to contract to expel the mass, which is now unnatural and irritating, the whole process resembles a miniature labor or childbirth.

Treatment.—The first and most important thing is for the woman to go to bed at once and remain there, with no exertion whatever, until her physician has seen her. If she is promptly treated, pregnancy may go on to full time.

If violent hemorrhage sets in the arrival of the doctor should be hastened with all speed. The hips may be raised on a pillow and cold applications used low on the abdomen. The foot of the bed should be raised upon a chair. All napkins and dis-

charges should be saved for the doctor's inspection in order that he may examine the embryo and determine the duration of pregnancy, and see whether the membranes are expelled intact.

The patient should not raise herself up or exert herself in any way while the bleeding continues; she should lie absolutely quiet until the physician has pronounced it safe for her to get up. She must not even get up to urinate or to move the bowels, and after severe hemorrhage should even be fed and turned.

After a miscarriage a woman should remain in bed for 10 *days and receive the same care as if she had had a normal childbirth.* More ill health follows miscarriage than childbirth, largely because women do not commonly realize the importance of taking care of themselves. The reason full time should be allowed for physiological adjustment following premature interruption of pregnancy is that the rhythmic glandular clockwork which has been wound and "set to go" for 10 menstrual periods is thrown out of gear. Involution of uterus and return of mammae to normal may take some time.

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If I Am to Be a Mother

If I am to be a Mother,
I must know where the wood nymphs dwell,
And the names of the dew drop fairies,
The trail to the elfin dell;
I must learn what moonbeams are made of,
And be sure that the night's abode
Is a valley of silver clouds
That you reach by a star dust road.

If I am to be a Mother,
I must search and never be still
Till I find every beauty and sweetness,
And cup my hands to their fill
In each brook and each quiet water
Till I have found their peace;
I will take in my heart their singing
And never let it cease.

If I am to be a Mother,
I must know what is sorrow, and pain,
And feel what it is to be humble
And then to be brave again;
I must find love in its fullest,
Radiant ecstasy,
Treasure the days of unbounded youth
That they may keep me free.

And when I have learned these secrets,
I must know the wisdom of men;
From life's own lips I shall take it,
Finding its truths, and then—
I know that I shall be ready
To cherish a life that is new,
And I shall be, God willing,
A Mother such as you.

ELINOR DAY. *Anthology of Student Verse for* 1930, Los Angeles High School.

CHAPTER XIII

PREPARATION FOR THE BIRTH OF THE CHILD

The Waiting

So much is there to vision now . . . so much
To ponder while my road draws surely near
Its ending—its beginning. Let no fear
Harass the slow, prophetic hours! I touch
These small, enchanting garments . . . and a song
Is somewhere wakened, like an echo tossed
Against the very sky but never lost—
Never forgotten . . . Now I shall be strong.
I shall find certain courage given through
The strength of him I love—who shares with me
This pulsing miracle that is to be.
How strange—of all we ever dreamed or knew—
Of all our world—to claim so large a part,
Oh, little thing that stirs beneath my heart!

CATHERINE PARMENTER.[1]

If the baby is to be born in the home, the supplies should be prepared at least several weeks in advance, both because the mother should have fewer duties as she becomes heavier on her feet, and also because of the relative uncertainty of all computations of prospective date of parturition. The mother should consult her nurse and physician in regard to the list of supplies which she is to prepare and the method of sterilizing.

Equipment for Confinement.—If it is left to the mother to prepare all the necessary equipment, she should have the following things on hand in addition to regular household provision for illness:

1. Several packages of *sanitary pads* such as are commonly used during menstruation.

2. A pound of *surgical cotton* for the small "wipes" and a small package of *sterile gauze* for dressing the cord.

3. If the *abdominal binder* is to be worn, 2 should be torn from heavy-weight muslin, about 16 by 40 inches, or longer if the woman is large.

[1] *Babies—Just Babies*, May, 1933.

4. A *small, soft blanket* with a square of old linen inside for first receiving the baby.

5. A generous supply of *hand towels*—at least 1 dozen—should be sterilized and put away. The new diapers may be sterilized and used, if the family supply of linen is too small to permit the convenient withdrawal of this number.

6. *Two or* 3 *hand basins or washbowls;* 2 *pitchers* or extra *teakettles* for holding hot and cold sterile water; 1 *slop-jar, bucket,* or *foot tub* for receiving waste.

7. *Safety pins* in 3 sizes, *shears, nail brush, soap,* and newspapers.

8. For *delivery pads,* a piece of quilted mattress padding or table felt 2 yards long may be purchased and cut into 2 or 4 pieces and bound. These may afterward be thoroughly laundered and used for the baby's bed. Or the pads for protecting the bed may be made from a square of cotton batting "tacked" between layers of cheesecloth. These may be made ½ to 1 yard square, and 2 will be sufficient. In an emergency, pads may be made of many layers of newspapers basted between muslin and then thoroughly ironed on both sides with a very hot iron.

Sick-room Equipment.—From the home medicine cupboard the following things will be used: bedpan, irrigating or enema can or fountain syringe; rubber sheet or square of oilcloth; sterile vaseline; sodium-hypochlorite (Dakin Solution), lysol or other antiseptic solution, clinical thermometer.

Some surgical supply houses now sell complete outfits for confinement already sterilized and sealed in compact packages. Naturally one pays for the processing and packing, but saves her own time and effort.

Preparing Supplies.—From an old sheet pieces should be torn suitable for pinning the following into packages as soon as they have been sterilized: 3 sheets, each wrapped separately; 3 pillow-cases in one package; 6 packages of 2 towels each; 12 to 15 packages of 4 sanitary pads each, 2 nightgowns or pajamas, wrapped separately; 1 pair of long loose stockings, which may be wrapped with 1 gown; 4 small or 2 large pads, wrapped separately, for protecting the bed during delivery.

Pledgets or "wipes" (if furnished by the mother) are made from either gauze or cotton loosely shaped into a mass the size and shape of an egg. The raw edges of the gauze are tucked in;

if cotton is used it is shaped and twisted into a rather firm, round mass. There should be a generous supply of these for wiping away blood and discharges and for use in case it becomes necessary to sew up a tear in the perineum. These also may be made from small pieces of soft old rags, carefully shaped and sterilized, if cost must be considered, or if an emergency occurs. These may be placed in a small pillow slip, or pinned up in muslin squares containing a dozen in each package.

Small pledgets are made by picking off and shaping small bits of cotton and dropping them in a pint Mason jar which has been boiled. These are useful for washing the nipple before and after nursing, and cleansing the baby's eyes in making the daily toilet. Swabs are made by winding bits of cotton about the ends of toothpicks. There should be a jelly glass full of these for the baby's nose, ears, and navel.

Sterilizing Supplies.—It is extremely important that everything coming near the mother during and following labor should be surgically sterile. Everything should be prepared and sterilized several weeks in advance of the expected date of confinement. Should the mother live near a hospital her nurse may be able to have the supplies sterilized at the hospital. If the mother must be responsible for this there are two possible methods which may be used in the home: ironing, and steaming, which will here be described.

Ironing.—As large a table as possible should be selected and padded all over with a clean blanket or quilt. This should be completely covered with a freshly laundered sheet. The iron should be scrubbed with soap and water, especially the handle. A freshly ironed towel may be folded for a handle holder. All the supplies to be sterilized are placed on a chair or table at one side. The operator puts on a freshly laundered dress or large apron, scrubs the hands thoroughly with a stiff brush, soap, and hot water. She should take several rows of pins from a paper, place them in a dish, and bake them in the oven.

She then proceeds as follows: First, she should run the iron over the entire table in order to sterilize the working surface. She should then iron the pieces of old sheet which are to be used as covers, and pile them upon the back of the table. Then she should iron the towels, and as soon as two have been ironed pin

them up in one of the pieces of sheet as if it were wrapping paper, making a neat package, and so on until all the articles designated above have been ironed and pinned up, remembering to bury all but the head of each pin in the package. She should *use an iron as hot as can be used without scorching, and rub it over and over each article, ironing it several times on each side.* She should arrange that there be no interruption while doing this, and should *not touch anything whatever except the iron and the supplies.* When done, the supplies will be arranged in a neat pile of packages on top of the table. She should then fold the ironing sheet over the whole thing, pin it compactly, and put it away until needed. She should not open this package for any reason whatsoever. The nurse will open it at the time of confinement. This sterilizing should be done two or three weeks before confinement is expected.

The gauze or cotton pledgets, swabs, safety pins, and everything which cannot be sterilized by ironing should be placed in glass jars, covered jelly glasses, or other suitable containers which have been boiled, covers and all, and have been dried with dry heat. When filled the containers should be placed in an oven and kept at a low baking heat for an hour.

Steaming.—The Children's Bureau of the U. S. Department of Labor, in a pamphlet on *Prenatal Care*, 1931, gives the following directions for sterilizing supplies:

> Wrap the sanitary pads, towels, and the sponges in packages of six each, and the remainder of the gauze squares in muslin and fasten with common pins. Put these packages and the muslin bags (five containing the cotton pledgets, the other the four cord ties and four gauze squares) into a pillowcase. Use a large wash boiler with a cover. Put water into it to a depth of six inches. Suspend the pillowcase containing the dressings in a hammock made from a towel or a piece of muslin (the hammock must not touch the water). Attach the ends of the hammock to the handles of the boiler. Wrap a cloth around the cover so that the cover will fit tightly. Steam an hour. Dry in the oven or in the sun by pinning the bag to a clothesline. Repeat the process the following day. Dry thoroughly. Put the pillow case away, unopened, until the articles are needed. If these articles have been sterilized more than a month, they must be sterilized again. The mother's nurse or the public-health nurse will explain to her the details of preparing and sterilizing these supplies.

Nursery Equipment. *Bed or Bassinet.*—A new clothes basket or splint delivery basket makes an ideal bed for the first 6 months. This may be nailed to the seat of an old chair without a back or mounted by a clever father upon a framework with casters. If so desired, the whole thing may be painted and made very attractive by appropriate decoration. A fitted pink or blue rayon lining which may be removed, with a wide flounce of dotted Swiss around the edge, makes a bassinet dainty enough for any baby.

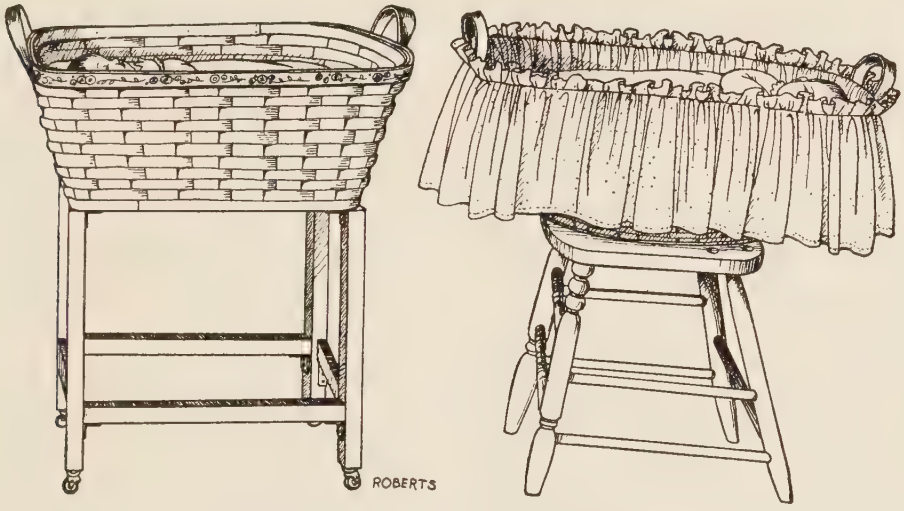


FIG. 47.—Two homemade bassinets.

It is desirable to have the basket attached to a firm support of suitable height for convenience and safety, as an active child may tip over a loose basket. A pillow may be carefully crowded into this basket to give a smooth, flat surface slightly higher at the head end. A head pillow is then unnecessary. A piece of rubber sheeting should be placed over the pillow. This is not necessary while the infant is very small. After the mother gets up she may use the rubber sheet from her own bed. A thin mattress should next be made by folding a piece of the table felting or quilted mattress padding, previously used for delivery pads, as mentioned, or even a piece of clean old quilt to fit the basket. This gives the smooth, firm surface desired, keeps the baby from contact with the rubber, and is easily washed and renewed. Four small blankets may be made by tearing a soft old woolen blanket into quarters and binding or crocheting the edges. Attractive crib blankets may be purchased very cheaply. Four small sheets can be torn from an old thin sheet and hemmed.

For the Bath.—An enameled infant's bathtub or small foot tub will be required. Two large, soft bath towels, if not found in the family linens, may be made from wide diaper cloth, or soft, absorbent Turkish toweling. Four washcloths may be made of outing flannel or bird's eye, or from an old soft towel.

An Enameled Tray.—This should hold: Castile or other mild soap in a celluloid box or small dish; fine talcum powder; boric-acid solution, boiled and strained through cotton; tube of sterile vaseline or other lubricant; small jar of applicators or swabs made of toothpicks wound with cotton; package of sterile dressings for the cord; small and large safety pins; medicine glass for sterile solutions.

A Bath Table.—A folding sewing table may have the legs sawed to make it a convenient height for holding the bath things while the mother sits in the low chair. This may be painted like the bassinet if desired. A folded cotton blanket or a heavy bath towel should be provided for the top of the table.

A Low Chair without Arms.—The legs of any chair may be sawed off and the chair painted to match the bassinet, or a low sewing rocker makes a very comfortable mother-and-baby chair.

Miscellaneous.—A drying rack for the diapers and bath things; drying frames for stretching the woolen stockings and shirts; a hot-water bag with flannel cover (the family bag may be scrubbed and cleaned, and fitted with a dainty cover in honor of this service, or a small bag may be purchased if desired); a reliable scale for the weekly weighing.

A Room for the Baby.—From the very start, some corner or room should be set apart for the orderly arrangement of the baby's belongings. These should be placed so as to require the fewest motions possible in performing the necessary operations involved in care of the infant.

From the day of his birth some part of the house should belong to the child. Theoretically he has a legitimate claim upon an adequate space for his needs and practically it is much easier to give it to him than to struggle forever with disorder and conflict of interests.

Furniture.—The nursery should be properly lighted, heated, and ventilated. It may be small or large, upstairs or down according to circumstances. It should, of course, be so located that the mother may easily see what is going on without too

much effort. The furniture may be very simple: made at home by the father; bought piece by piece at second-hand stores and decorated according to some consistent plan, or purchased new if finances permit.

The wardrobette here illustrated (Fig. 48) was made by a neighborhood carpenter, and can be made by any father or uncle who has had manual training. It is designed to comprise the chief article of furniture for the personal use of the child from

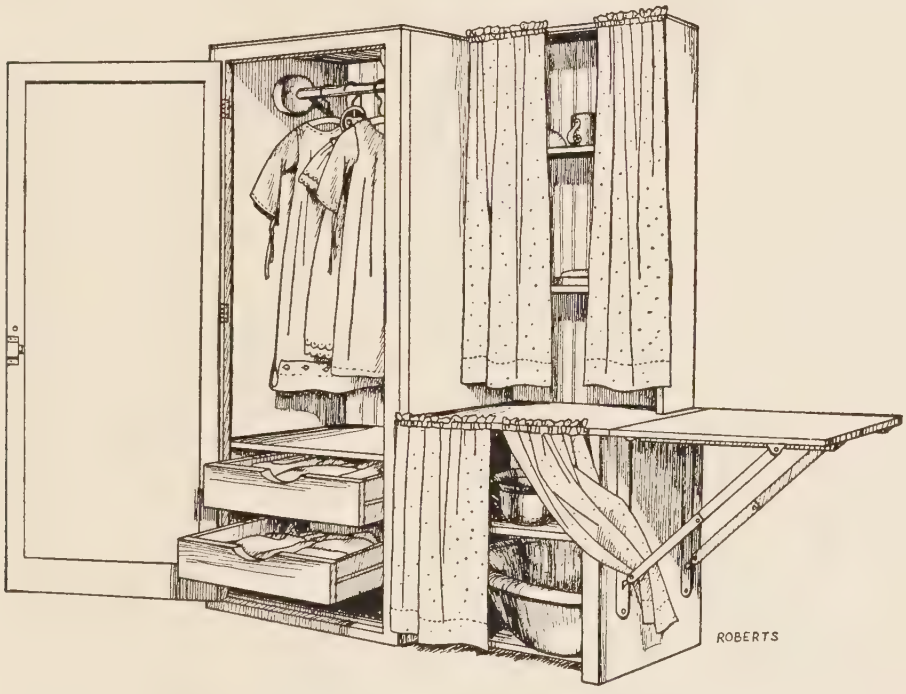


FIG. 48.—The wardrobette. (*Department of Home Economics, University of Kansas.*)

birth to adolescence and is appropriate to a situation in which space is limited. The shelves for holding the infant's toilet equipment may be replaced by a mirror for the five- or six-year-old. The bathtub may be replaced by books and playthings, and the drop leaf affords useful space for play or study.

The child should have chairs and tables adjusted to the various levels of his growth. Fortunately, he finds many uses for his outgrown furniture, so it is not a matter of discarding them when it becomes apparent that he needs a larger chair and table. Because the child will need to have several of these they should be inexpensive, and homemade when possible. The further adaptation of the child's room to his growing needs will be discussed later in the text.

PART II

ENTER—THE CHILD



Reproduced by courtesy of Lorado Taft.

The Scientist

The Spiral Nebula in Ursa Major, that forever turns
Slowly like a flaming pin-wheel . . . thus are worlds born;
Thus was the sun and all the planets a handful of million years ago.

He that has gone mad and insane may call himself a king,
And behold himself in a king's palace, with feasting, and dancing women, and with captains,
And none can convince him that he is mad,
Slave of hallucination. . . .
We that weigh the atom and weigh a world in the night, and we
Who probe down into the brain, and see how desire discolors reality,
And we that see how chemical energy changes and transforms the molecule,
So that one thing and another changes and so man arises—
With neither microscope, nor telescope, nor spectroscope, nor finest violet ray
Have we found any Father lurking in the intricate unreasonable drive of things
And the strange chances of nature.

The Poet

O Priest, is it not enough that the world and a Woman are very beautiful,
And that the works and tragic lives of men are terribly glorious?
There is a dance of miracles, of miracles holding hands in a chain around the Earth and out through space to the moon, and to the stars, and beyond the stars,
And to behold this dance is enough;
So much laughter, and secret looking, and glimpses of wonder, and dreams of terror. . . .
It is enough! it is enough!

The Priest

Enough? I see what is enough!
Machinery is enough for a Scientist,
And Beauty is enough for a Poet;
But in the hearts of men and women, and in the thirsty hearts of little children
There is a hunger, and there is an unappeasable longing,
For a Father and for the love of a Father . . .
For the root of a soul is mystery,
And the Night is mystery,
And in that mystery men would open inward into Eternity,
And know love, the Lord.
Blessed be his works, and his angels, and his sons crowned with his glory!

A pause

THE WOMAN WITH A BURDEN IN HER ARMS COMES IN SLOWLY.

James Oppenheim,

from *Night*, by permission of and special arrangement with Alfred A. Knopf, Inc., authorized publishers.

CHAPTER XIV

THE BIRTH OF THE CHILD

The Blessing of the Beds

Make the bed,
And make the bed,
The sheets are smooth
And the blankets spread.

Back and forth
Round the bed we go,
I and the child
I do not know.

If it should be
A son I bear,
May he be wise
And kind and fair.

Or if a girl-child
It should be,
May the blessings on
Her bed be three.

The first bed
Is the marriage-bed.
May Joy and Tenderness
Stand at its head.

And when in child-bed
She shall lie
May Victory
Herself draw nigh.

And when at last
Comes the third bed,
May Peace bend down
Above the dead.

Ah, Love! ennoble
With thy breath
Bride-bed, birth-bed
And bed of death!

Make the bed,
And make the bed,
The sheets are smooth
And the blankets spread.

ELIZABETH COATSWORTH.

The Approach of Labor.—Many young women approaching their first confinement are disturbed by vague fears and forebodings. They have heard many conflicting reports as to the suffering involved and they may even wonder, in moments of depression, whether a baby is actually worth the price. It is true that childbirth sometimes involves acute suffering, and the hours of waiting are almost worse to endure than the period of actual pain. However, there is no human suffering which is so promptly and completely forgotten, and no weariness from which one so quickly and completely recovers as the pain and fatigue of childbirth. If the woman is well nourished and in good phys-

ical condition, she usually wakens from her nap "feeling quite like herself" and eager to enter upon her new maternal estate.

Dorothy Canfield thus describes the second confinement of her heroine in *The Deepening Stream.*[1]

On the stormy day in December, when Matey lay down on her bed, shuddering in the onset of labor-pains before the birth of her second child, she saw out of the window the old beech tree, stripped to the boles, magnificently glorying in the battle with the wind and snow. She faced her own battle with a new heart. The present, anguish that it was, dwindled to its proper place in the great perspective. She remembered with pity the faltering panic of her first confinement. The pains were as great now but she was so much greater.

"No, no! Adrien," she cried to him, seeing him turn white at an outcry of hers . . . "It's worth it!"

He turned paler than ever, his face transfigured by love and by shared suffering.

Oh, wonder and glory of life that could bring such moments, thought Matey, bracing her soul against the old beech tree as a new rage of pain swept over her. This too was part of the banquet spread before the living.

The approach of childbirth should bring the expectant parents together in tenderness and communion of spirit. This can come only if the expectant mother has the "great perspective" which brings the courage and serenity which is appropriate to the mystic occasion of the birth of a new soul, hostage to immortality, out of one's own body. Fears may be conquered only by filling the mind so full of visions and activities and interests that there is no room for anxious anticipations.

The Physiology of Labor.—The exact cause of labor is still a matter of speculation. DeLee says:

Why should the uterus, which has carried the ovum for so many months, suddenly violently expel it? Nature certainly recognizes the right moment for the expulsion, since it is almost always accomplished at a time when the child is best able to carry on extrauterine existence and before it has become too large to pass safely through the parturient canal. Why labor should occur on the completion of ten menstrual cycles is unknown.[2]

[1] Canfield, Dorothy, *The Deepening Stream*, Harcourt, Brace & Company, 1930.

[2] DeLee, Joseph, *Principles and Practice of Obstetrics*, p. 120, 5th ed., W. B. Saunders Company, 1930.

The most tenable explanation is that of alteration in the endocrine balance. It is known that the corpus luteum degenerates during the last weeks of pregnancy. It seems reasonable to assume that the pituitary, finding itself unrestrained, causes contractions of the uterus to occur. That this is not the sole cause, however, is apparent from the fact that the corpus luteum of pregnancy has been removed in experimental animals without bringing on labor; further, the ovaries have been removed during pregnancy, and labor has occurred normally.

Another suggestion is that the placenta, being a temporary, short-lived organ, begins to undergo chemical changes which make it assume the character of a "foreign body," with consequent effort of the uterus to expel the irritant.

A little reflection upon the exceedingly complex physiological chemistry of the body, as sketched in the chapters on diet and on glands of internal secretion, will make it seem probable that there is no single cause, but that the process involves extensive chemical and mechanical adjustment.

The bringing forth of the child is variously called labor, travail, delivery, accouchement, confinement, and childbirth. Labor may be said to be divided into two periods: "insensible labor" (the French call it "travail insensible"), and the period of painful contractions. The first period begins with the return of the child from the abdomen to the pelvis. The second period begins with the first regular, painful contractions of the uterus.

The Signs of Approaching Labor.—The first or insensible period shows several phenomena which may be recognized and may indicate to the mother that her pregnancy is drawing to a close.

"*Lightening.*"—Two weeks or longer before labor the child starts on his journey to the outer world and begins to settle down into the pelvis. The woman's shape changes; the upper part of the abdomen becomes smaller and the lower becomes larger. She breathes more easily and feels lighter, but walks with greater difficulty. She is apt to have a return of constipation and frequent urination, owing to pressure such as she had before the child rose out of the pelvis at 4½ months. The process of stretching the muscles and ligaments and getting ready for birth of the child really starts at this time. When women say they

were only in labor 1 hour or 2 hours, the truth is that the downward journey of the child had taken place so gradually and painlessly that they had not been aware of it, and were conscious only of the expulsion of the child. This is as it should be.

"*False Pains.*"—Irregular and occasional contractions of the uterus occur during the entire period of pregnancy. As labor approaches, however, these become strong enough for the woman to become conscious of them. They may be more or less painful but are apt to be merely "griping" or "drawing" in character. Sometimes the woman will be conscious of these for from 1 to 4 weeks before labor. If they are only occasional and occur at irregular intervals they are called false pains. It is well to report these to the nurse and the doctor, however, in order that they may hold themselves in readiness for service.

"*The Show.*"—During pregnancy the mouth of the uterus becomes plugged with mucus. When the birth canal begins to enlarge or dilate for the passage of the child this plug of thick white mucus tinged with blood comes away, usually 24 to 48 hours before the birth of the child.

The Stages of Labor.—The second or conscious period of labor may last from a few minutes to many hours according to the relation between the fetal and maternal structures, the mother's vigor and organic competency, etc. This period is commonly divided into three stages.

The First Stage of Actual or Conscious Labor Is That of Dilation. This covers the period required for the complete stretching of the cervix of the uterus ready for the child to come out of it and pass through the vagina and pelvic outlet. This stage is characterized by contractions of gradually increasing frequency and severity. The woman may be conscious of these for from 12 to 20 hours.

True labor pains usually begin with more or less painful contractions coming on every 10 or 15 minutes, gradually increasing in frequency and severity until they occur every 1 to 3 minutes. It is usual to give some anaesthetic if they are severe (see Appendix B, page 659). Between pains a woman usually feels quite comfortable and may even sleep. The first stage lasts longer in a primipara (a woman who is having her first child) than in a multipara (a woman who has borne one or more children).

Breaking of the Bag of Waters.—One of the reasons dilation of the birth canal may progress so painlessly is that the contractions of the uterus force the soft amniotic sac ahead of the child. The pressure finally becomes so great that the placental membranes are ruptured and the amniotic fluid escapes in a rush. If this occurs too soon the canal must be dilated by the head of the child, a condition known as "dry birth." Such labor tends to be longer and more painful than normal. The breaking of the bag of waters should mark the end of the first period; the cervical canal should now be fully dilated and continuous with the vagina.

The Second Stage of Labor, or the Period of Expulsion.—This is the name given to the period required for the child to pass from the uterus, through the vaginal opening and the outlet of the pelvis, into the outer world. The pressure of the head of the child upon the rectum causes a feeling of urgent necessity to empty the bowel. The woman now "bears down" and thus assists the progress of the child. The stretching of the perineal muscles is the most painful part of the entire experience, and the woman can, by courageous cooperation, materially assist nature and shorten the period. Anaesthetic of some kind is usually given during this stage, which may last from a few minutes ("one pain" or "two pains") to one or more hours.

The Third Stage or Expulsion of the Afterbirth.—The expulsion of the child is followed by a short period of rest of 20 to 30 minutes, after which the uterus again contracts vigorously and expels the placenta. If the third stage is delayed physicians sometimes give pituitrin (see page 117) to hasten the expulsion of the placenta and lessen the danger of hemorrhage from a relaxed uterus.

Afterpains.—The uterus should contract rapidly into a round, hard mass about the size of the child's head, which can be felt through the abdominal wall. This is Nature's way of stopping the bleeding of the surface from which the afterbirth was separated. If the muscles in the wall of the uterus do not fully contract the woman may have a severe post-partum hemorrhage.

The nurse should occasionally grasp the uterus through the abdominal wall during the first 24 hours, to see if it feels hard. If it should flatten and feel soft she should rub and squeeze it

until it draws up into a hard lump again. Also, when the child nurses the uterus contracts; hence the child should be put to the breast regularly from birth. The contractions are sometimes more or less painful, and are called "after pains." Occasionally they are severe enough to require medical relief.

Preparation for Labor.—If delivery is to take place in a hospital the doctor should be kept informed of the onset and progress of all symptoms, and he will indicate when the transfer should be made. The mother's bag containing her toilet necessities and the baby's clothes should be prepared early. If the doctor is not in close touch with the situation the woman should go to the hospital at the first appearance of definite labor pains and it is safer to go as soon as "the show" appears. If she lives at a distance from the hospital and must make a journey by train or auto she should avoid risk by going to the hospital as soon as "lightening" is definitely recognized, since precipitate labor may occur especially under the excitement and exertion of a trip.

If delivery is to take place at home the doctor must be kept closely informed from the onset of "lightening" until he appears to take charge of the situation. Certain preparations should be made for delivery of the child. The nurse should arrive early and put things in order. Emergencies do arise, however, and the family may need to have quarters and equipment ready. The room to be used should have been thoroughly cleaned and kept in order for some time. Places should have been found for things, ordinarily in the room, which will not be needed. The belongings of other members of the family should be removed. For 2 weeks this room is to belong exclusively and absolutely to the mother. If necessary the nurse and baby may also share it. It is much better, however, for the nurse and baby to occupy an adjoining room. When labor begins the birth chamber should receive a final setting in order. The woodwork and furniture should be wiped with a clean, damp cloth. The light should be put in order, and a strong extra light made ready in case it should be necessary to deliver the baby at night. The heat and ventilation should be carefully arranged.

The baby's blankets, first clothes, bath equipment, the boric-acid solution for its eyes, the vaseline or cold cream for its first

greasing, may all be laid out in an adjoining room, or wherever the nurse plans to give the baby its first bath.

The supplies listed on page 233 should be arranged upon small tables conveniently accessible to the doctor. The bowls and pitchers should be washed with hot soapsuds and wiped all over with a piece of gauze wet in an antiseptic solution.

A couple of teakettles (borrowed if necessary) should be filled, brought to boil and set aside to cool. It is easy to secure hot sterile water quickly, but it should not be forgotten that cold sterile water also will be required.

It is well to have the family instructed as to the regulation of fires, keeping water hot, preparing a lunch for the doctor and nurse, if labor lasts through the night, etc.

Making the Bed.—A mattress pad or folded quilt should be placed over the mattress, then the lower sheet is spread and folded under at the corners. Unless the sheet is large enough to tuck under, at least 12 inches all around it should be pinned to each corner of the mattress underneath with large safety pins, taking several stitches with each pin so that it will not tear either mattress or sheet. It is very important that the mattress coverings should remain firmly and smoothly in place.

Across the middle of the bed the piece of rubber sheeting or oilcloth is placed, which should have been wiped on both sides with an antiseptic solution. This is covered with a sheet folded over crosswise (the "draw sheet"), which is drawn well under the mattress and pinned with safety pins. The patient's hips should come about the middle of this sheet. It is much easier to change this often than it is to change the sheet covering the entire mattress. Since this is the permanent bed upon which the mother will lie at the termination of delivery, it should be protected with another clean sheet, which will be slipped out from under the mother at the end, leaving her on a perfectly clean, permanent bed. The pads for protecting the bed will be placed over the top sheet as required. The pan or jar for waste may be placed on the floor under the edge of the bed. A basin should stand by the side of it for receiving the placenta. Everything brought into the room should be absolutely clean and sterile.

Preparing the Patient.—As soon as labor is known to have begun, the patient should be given a large soapsuds enema, which

is sometimes repeated in order to prevent escape of fecal matter during the second stage of labor. She should empty the bladder frequently during the entire period (a vaginal douche should never be used either before or after confinement without explicit orders from a physician). She may then take a sponge bath, or this may be given to her by her nurse. She should not get into a tub, since she might infect the birth canal with the water in which the body is bathed.

The hair, if long, should be parted and braided into two braids, firmly tied at the ends. The woman may then put on a gown or pajamas, her bedroom slippers, and kimono. She may occupy herself in any way she likes: reading, talking, moving about, and attending to small concerns which may make the trying time pass more rapidly. She should eat and drink as if nothing were the matter except that the food should be easily digested and of a moderate quantity. She must not give way to nervous apprehension, but must strive for poise and courage, and think of the joy of the morrow rather than anticipate the pain of coming moments.

The nurse should further prepare the patient by scrubbing the inner surfaces of thighs, the abdomen and the genitals with warm water and soap. She should then take a pair of sharp shears and clip the pubic hair as short as possible or shave with a safety razor as this makes it very much easier to keep the parts aseptic both during and after labor. The nurse should next wash all parts which are to be exposed with an antiseptic, such as 5 per cent carbolic, 3 per cent lysol, or mild sodium-hypochlorite (Dakin) solution. She will then put a sterile pad over the vulva and fasten it back and front to a bandage belt.

When the Doctor Comes.—The nurse should bring a basin of hot water, soap and hand brush, and nail file, and let the doctor first scrub his hands outside the birth chamber. He will then put on a sterile gown and complete the cleansing of his hands in a basin of disinfectant. When he has made the first examination the nurse should have water, soap, brush, disinfectant, and towel again ready for his use. If he uses rubber gloves, as most physicians do, she will sterilize these by boiling after each using.

The doctor and nurse should then look over the equipment and see that everything is ready and that the nurse understands the doctor's methods and desires.

Delivery.—When the second stage of labor begins, the nurse removes the patient's kimono and slippers, and throws a sterile sheet around her, under which she neatly folds up the nightgown, or else replaces it with a sterile short gown, such as the jacket of a pajama suit. She then places the patient on the bed with the sterile pads under her and the sterile sheet over her. The nurse should now put on her the stockings which were sterilized and pinned up with one of the gowns.

Every person entering the room or assisting in any way should wear a large clean apron or sterile sheet. The proper way to use a sheet for an apron is as follows: Hold the sheet up so that the middle crosswise crease will drop from chin to feet of the person who is to wear it. The sheet is folded over at the top so it will just clear the feet at the bottom. It is then brought smoothly around under the arms and the upper corners crossed in the back and brought over the shoulders and pinned to the front; that is, the right upper end of the sheet is pinned to the sheet in front of the left shoulder, and the left upper end in front of the right shoulder. This can be done in such a way that part of the sheet falls over the sleeve and arm. When properly adjusted it allows one to move around as freely as if wearing a real apron.

As soon as the baby's head is born the nurse should quickly wipe the mucus from the mouth with a bit of sterile gauze and wash each eye with a separate piece of gauze wet in boric-acid solution. When the baby is released from the terrific squeezing to which he has been subjected in the birth canal, unless he has been overcome by deprivation of oxygen, pressure, or too much anaesthetic, he gasps, draws his first full breath, and tells the world what he thinks of his chilly reception on being precipitated from a temperature of 98.5° within his mother's body into one of 75° or 80° in the delivery room! If the baby is slow in responding to the situation he must be made to breathe by artificial respiration and stimulation.

As soon as the cord is cut the nurse should cover it with a piece of sterile gauze; she then wraps the baby in a soft piece of old toweling inside a warm blanket and lays it on its right side in a warm, safe place, while she helps the doctor with the mother.

She again tidies up the patient somewhat, places her in a comfortable position, and allows her to rest until time for the

afterbirth to come away, when the contractions of the uterus start up again for a few minutes.

The nurse now gives the baby a little further attention, looks it over carefully to see if it is normal in every way, and shows it to the doctor for confirmation of her judgment. The doctor will now drop the prophylactic silver preparation in the baby's eyes (see page 219). The nurse then anoints it thoroughly with oil, vaseline, or cold cream, to soften the sticky, cheesy coating with which most babies are covered when born. She again wraps it up and makes it comfortable until after the mother is entirely through and settled to rest. Usually the baby goes promptly to sleep as soon as he is warm.

Repair of Tears.—When the perineum is torn during the delivery of the child the physician will sew up the tear before the nurse adjusts the dressing. The patient should be placed crosswise of the bed, and a very good light will be needed. The nurse will cleanse and prepare the parts as directed by the physician. It is very important that all tears, even small ones, be repaired as soon as they occur, thus saving ill health and hospital and surgeon's fees later. The matter is not difficult, as the woman has usually had some anaesthetic, the parts are sterile, and are going to be kept surgically clean for the period of healing anyway.

After the afterbirth has been delivered and the doctor has pronounced everything finished, the nurse quickly sponges off the exposed parts of the body, removes soiled pads, places a sterile dressing over the vulva, adjusts the binder, and pins the dressing to it back and front. She places a hot-water bag at the mother's feet, gives her some hot milk or other nourishing drink, adjusts light and ventilation, and lets her take a much-needed rest. The mother will usually go quickly to sleep, and a great peace falls upon the household!

The duties of the physician at the time of the birth of the child may be summarized thus:

1. Care of the mother. The doctor should be present at least during the second stage of labor and should exercise scrupulous care as to cleanliness and asepsis. He should exercise good judgment in the use of anaesthetics, instrumental assistance, etc. He should examine the afterbirth to make sure that no fragment

remains in the uterus. He should see that the uterus contracts properly. He should repair any tears of the perineum.

2. Care of the child. He should see that the child breathes properly. He should examine the child for defects. He should see that the cord is properly tied and dressed. He should put prophylactic drops in its eyes and turn it over to the nurse. Before he leaves the house he should fill out a birth certificate.[1]

Birth

Just when each bud was big with bloom,
And as prophetic of perfume,
When spring, with her bright horoscope,
Was sweet as an unuttered hope;

Just when the last star flickered out
And twilight, like a soul in doubt,
Hovered between the dark and the dawn,
And day lay waiting to be born;

Just when the gray and dewy air
Grew sacred as an unvoiced prayer,
And somewhere through the dusk she heard
The stirring of a nested bird—

Four angels glorified the place:
Wan Pain unveiled her awful face;
Joy, soaring, sang; Love, brooding, smiled;
Peace laid upon her breast a child.

ANNIE R. STILLMAN.[2]

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[1] The father should follow up the matter of registering the birth of his child and see that the birth certificate is actually filed with the local and state registrars of vital statistics. The laws of our own and other countries are full of age requirements. Legal evidence of citizenship and of age may be necessary at any time during the life of the individual in order to enable him to travel; to inherit property; to enter professions; to marry; in order to determine criminal liability; age of entering and leaving school, etc. A busy physician, although under legal penalty, in most states, for failure to register a birth, may neglect actually to send in the certificate after it is made out; hence the parents should follow up the matter later.

[2] *The Willows Magazine.*

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"Where have I come from, where did you pick me up?" the baby asked its mother.

She answered half crying, half laughing, and clasping the baby to her breast;—

"You were hidden in my heart as its desire, my darling.

You were in the dolls of my childhood's games; and when with clay I made the image of my god every morning, I made and unmade you then.

You were enshrined with our household deity, in his worship I worshipped you.

In all my hopes and my loves, in my life, in the life of my mother you have lived.

In the lap of the deathless Spirit who rules our home you have been nursed for ages.

When in girlhood my heart was opening its petals you hovered as a fragrance about it.

Your tender softness bloomed in my youthful limbs, like a glow in the sky before the sunrise.

Heaven's first darling, twin-born with the morning light, you have floated down the stream of the world's life, and at last you have stranded on my heart.

As I gaze on your face, mystery overwhelms me; you who belong to all have become mine.

For fear of losing you I hold you tight to my breast. What magic has snared the world's treasure in these slender arms of mine?"

RABINDRANATH TAGORE,
from *The Crescent Moon*,
The Macmillan Company.

CHAPTER XV

THE PUERPERIUM

Organic Changes.—The period required for the return of the uterus to its normal size and position, called the *puerperium*, usually requires 5 to 6 weeks. Rapid absorption of the extra uterine tissue takes place, a new lining is formed, and the large overstretched muscular sac weighing about 2 pounds becomes again a small compact organ weighing about 2 ounces. The supporting ligaments and the relaxed abdominal muscles also regain their tone and contract to their original size. By the seventh to the tenth day the uterus has usually returned from the abdomen to the pelvis and can no longer be felt above the symphysis pubis. Some physicians determine the time of sitting up by this, permitting a woman to sit erect as soon as the uterus is no longer palpable above the pubis.[1] This shrinking of the uterus is called involution (see page 93). Involution proceeds more rapidly in women who nurse their children, as the mammary hormone seems to have a stimulating effect upon the uterine tissues. While the uterine structure is undergoing this reduction the supporting ligaments are contracting, and the adjacent tissues of vagina, bladder, and bowel are recovering from the prolonged pressure, distortion, and congestion.

Duty of Physician.—The attending physician should pay just as strict attention to the puerperium as to the pregnancy. He should consider it his responsibility to see: (1) that the milk flow is successfully established; (2) that the mother leaves her bed and becomes adjusted to her daily routine safely and happily; (3) that the pelvic organs have returned to normal size, relation, and condition. No matter how normal the situation seems to

[1] Williams, J. Whitridge, *Obstetrics*, p. 350, D. Appleton-Century Company, 1912; Cook, Joseph, *A Nurse's Handbook of Obstetrics*, p. 181, J. B. Lippincott Company, 1924.

be, he should make a thorough pelvic examination when the baby is from four to six weeks old. He should visit the mother and babe every day until nursing is fully established. If everything is all right, he may then make a call every other day until the mother leaves her bed. Where the distance prohibits this service, the woman should, if possible, go to the nearest hospital for confinement, or to the home of a relative or friend near her physician.

The Lochia.—The bleeding from the small blood vessels ruptured by the separation of the placenta, mingled with mucus and sloughed-off uterine lining, form a discharge called the lochia, which changes in color from red to brown and then to yellow. It gradually lessens, entirely disappearing when involution is complete. The odor is slightly musty or "meaty," but not offensive. If the odor becomes offensive or pus-like it should be called to the doctor's attention.

Weight.—The new mother should return, during the puerperium, to about her normal, prepregnant size, certainly to not less than her normal weight. Some women remain a little heavier ever afterward, and most women are somewhat heavier during lactation, but lose some weight when the baby is weaned; other women lose weight during nursing.

Confinement in Bed, "Lying-in."—It is customary for a primipara to sit up about the ninth or tenth day after the birth of the child, get into a chair within the next day or two, and dress and leave her room about the fourteenth day. Multiparas having no complications shorten this program by sitting up about the seventh day and dressing on about the tenth day. These rules do not fit all cases. Vigorous peasant women scarcely go to bed at all, while women who are not vigorous and generally strong may need 2 to 3 weeks of absolute rest, especially if a satisfactory milk supply is to be secured. If perineal repair is made a longer stay in bed is necessary. In general, there is a tendency on the part of many obstetricians to encourage greater freedom of movement than formerly. Some permit uncomplicated cases to get up to the bedside commode after the milk flow is fully established, and have their patients well propped up in bed to eat almost from the start, believing that better drainage of the uterus is hereby secured as well as quicker return

of abdominal muscle tone. Indeed, many women feel quite ready to get up after 2 or 3 days of rest. This is inadvisable on account of the weight of the heavy uterus upon the relaxed ligaments, which may cause "falling of the womb," "bearing down," and "subinvolution" (page 93).

Lactation.—During the first 48 to 72 hours the breasts secrete a yellowish, watery substance called *colostrum*, which is exactly adapted to the digestive capacity of the infant and meets his needs. It acts as a laxative, clearing the bowel of meconium, and supplies necessary energy fuel. About the third day the milk glands begin to function, and the breasts "fill up with a rush." The activity of the milk glands is stimulated by the sucking of the child both before and after the flow starts. The secretion of milk normally continues from 9 to 12 months, and may sometimes be prolonged to from 18 to 24 months if the child is not weaned.

The Hygiene of the Puerperium: Care of the Mother. *Quiet.* The first need of the mother after the strenuous experience of labor is quiet. As has been said, she should be given nourishment, left in a fresh bed, with feet warm, air fresh, and light adjusted, and permitted to rest until she spontaneously awakens. During the lying-in, and indeed, during the entire puerperium, she must be protected from excitement and fatigue. When the baby has been born at home and the mother has many accessible relatives and friends there is sometimes created a situation calling for diplomatic finesse, since each well-wisher does not know the sum total of the demands the day may bring to the precious strength of the object of affection. It is often important and necessary to have the doctor instruct the nurse as to exactly how many callers, length of call, and time of call his patient's condition permits.

Diet.—For the first 3 days, or until the milk flow is successfully established, the diet should be nourishing but easily digested, beginning with fruit juices, milk, and milk drinks for the first 12 to 24 hours, and adding toast, eggs, milk soups, cereal, vegetables, and fruits as the appetite of the patient returns. Some obstetricians do not limit the food intake even at first. Dr. Bacon says if the woman "is hungry and wishes a hearty meal immediately after labor, there is no reason why her wish may

not be gratified."[1] After the milk flow starts and immediate danger of infection is past, the patient may rapidly return to the diet of pregnancy as outlined in chap. X. She must now literally "eat for two." Her need for calcium, phosphorus, and protein is increased even over that of pregnancy. This is shown by the fact that nursing mothers as well as pregnant women tend to show negative calcium and nitrogen balance.[2] As in pregnancy, the child tends to take his requirement from the mother's tissues if not supplied from her food. Fortunately, cow's milk supplies the increased need in both calcium and protein. Not less than 1 quart per day will usually be required. Some women will require as much as 2 quarts daily to maintain their calcium balance and preserve their own tissues.

The appetite is usually increased, sometimes to a voracious degree, some women consuming as much as 4,000 to 5,000 calories per day. Of course common sense must be used in such a case, or the woman may accumulate excessive weight and fat. Ordinarily in a woman who is healthy and active and who eats regularly and chews thoroughly, the appetite is a fairly safe guide as to the proper amount to be eaten. She should eat a balanced and varied diet, and in event of doubt should analyze her diet for 1 week as instructed in Appendix A, page 645.

She need have no fears that particular foods will "give the baby colic." Whatever agrees with her will agree with the baby, except in the rare condition of protein sensitization (see page 279).

The mother's food during pregnancy and lactation is the baby's food. No one must forget this for a moment. He has nothing out of which to build his bones, teeth, muscles, and brain except the food elements she gives him from her own blood stream via the mammary glands, with the addition of certain protectives which will be named later.

Urination.—If the woman is unable to void spontaneously, the doctor usually catheterizes the bladder at the end of labor, leaving it empty. Sometimes the new mother uses a bedpan for the first time following the birth of her child. The unaccus-

[1] Bacon, Charles S., *Obstetrical Nursing*, p. 238, Lea & Febiger, 1924.

[2] Wilson, Charles A., *Third Conference on Research in Child Development*, Part II, p. 254, National Research Council, Washington, D. C., 1929.

tomed position and the general relaxation of all ligaments and muscles may make it difficult to void urine. If urine has not been passed before 10 hours after the birth of the child, the fact should be promptly reported to the doctor; sooner than this if there is any distress or discomfort. The amount of urine will depend in part upon fluids taken, but should be more than usual on account of the great amount of broken-down proteins from the uterus which must be excreted from the system. If there is difficulty in urinating the nurse may try the time-honored expedients of having the patient listen to trickling water, putting hot water in the bedpan, and applying heat to the region of the bladder. Bacon permits a patient to assume a kneeling position in bed over a small basin held by the nurse, believing everything should be tried before catheterization.[1]

Bowels.—If the bowels have been properly emptied at the onset of labor it will not be necessary to have a movement until about the morning of the third day after. Many physicians give a mild laxative on the evening of the second day. After the third day there should be a regular, daily movement, preferably soon after breakfast and before the bath. The use of a small soapsuds enema or a suppository is usually permitted by the physician for a few days until a regular habit and familiarity with the bedpan are established. The time of giving and the kind of laxative used will be indicated by the physician.

Air, Light, and Warmth.—The mother should occupy a light, well-ventilated room, the quietest and most pleasant in the house. Sunshine and fresh air are necessary to both mother and child. The temperature should be kept at not over 70°, and 65° to 68° is usually better. It is debilitating to lie in a warm, close atmosphere. The old method of keeping mother and child in a hot, dark, stuffy room, to prevent them from becoming "chilled," was the surest way in the world to make them highly sensitive to cold. This idea doubtless arose from the fact that childbed fever begins with a chill. It was natural to assume that exposure to cold caused the fever.

Both mother and babe must be kept warm, of course, but this must be done with warm lightweight blankets and hot-water bags, if necessary, rather than with heavy covers or hot, stale

[1] Bacon, *op. cit.*, p. 233.

air in the room. In warm weather all windows should be freely open, and in cold weather all windows should be down from the top. Even in the most severe weather a little crack should be left at the top at all times, to make sure that the air in the room will not be stagnant and that it will be constantly changing from the top, where the hottest, stalest air is always found. "Good air is *moist, cool,* and *moving.*"

The mother and babe may be protected from a direct draught by some kind of screen. A blanket over two chairs or even a clothes-drying rack or an open umbrella does very well.

The room need not be darkened except while the mother naps. However, the eyes of both mother and babe should be shaded at all times from direct light.

The Mother's Bath and Bed.—The mother should have a sponge bath every day, and have a fresh gown daily, or at least two gowns, one for night and one for day. The bed linen should be changed often enough to keep it neat and fresh; the bed should be smooth and orderly at all times. The hair should be combed daily and if long braided in two braids. It rests both body and mind of the mother to have her bed and person neat and clean and her room attractive and pleasant.

Abdominal Binder.—There is difference of opinion as to the use of the abdominal binder. Some physicians think it tends to cause rather than prevent displacements of the uterus, because it tends to press the uterus backward as the woman lies upon her back. Some physicians object to the use of the binder while the patient is in bed, but permit its use when a woman first gets up, in order that the relaxed muscles may have some support while recovering their tone and shape. Most physicians permit its use for at least a few days after the birth because of the comfort and support it provides. The best plan is for every woman to consult her physician in regard to this and follow his advice. If the binder is used it should be applied smoothly, pinned with safety pins placed closely together, and fitted with pinned darts.

Care of the Genitals.—The genital region should be kept sterile at all times, since infectious matter may find its way into the uterus (which is somewhat like a raw wound after the separation of the afterbirth), and cause childbed fever. The nurse should

scrub her hands with soap, hot water, and brush before waiting on the mother. Every time the parts are uncovered for urination or bowel movement, all dressings should be dropped on an open newspaper. Before putting on clean dressings the parts should be cleansed with sterile pledgets of gauze or cotton dipped in boiled water or an antiseptic solution. Each pledget should be

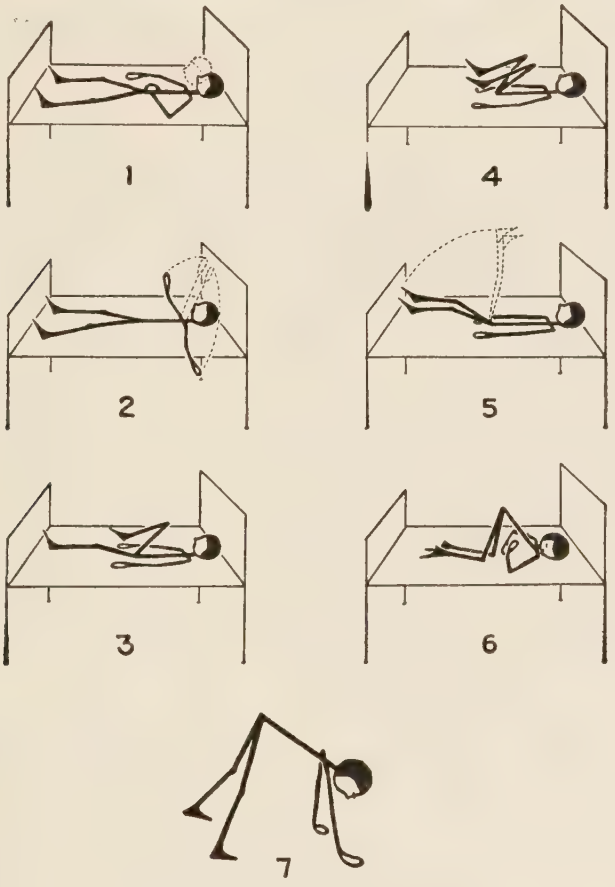


Fig. 49.—Bed exercises.

thrown on the newspaper as used, and never dipped in the solution a second time. The anus (opening of the bowel) should first be cleansed, then the labia. The hospital method is to cleanse the anus, then rinse the other parts by pouring the solution from a sterile pitcher. When stitches have been taken this method should always be used. After the parts have been made perfectly clean, a fresh, sterile pad should be applied. The newspaper containing the soiled dressings should be burned at once.

Exercises.—Bed exercises to restore tone and vigor to the various muscles of the abdomen and back are now commonly

advised,[1] and are much more effective in restoring the "shape" of the abdomen than is the binder. These exercises should be undertaken only under the physician's advice. Excellent illustrations from photographs are found in *Getting Ready to Be a Mother* and in *Obstetrical Nursing*, both by Van Blarcom.[2] These exercises are also illustrated in Fig. 49.

Hygiene of the Puerperium: Care of the Baby. *The Baby's First Bath.*—The water should feel pleasantly warm to the bare elbow of the nurse. If a bath thermometer is available the water should test about 98° to 100°. The nurse spreads a bath towel covered with an old soft linen towel over the bath table. She carefully wipes off the grease, carrying with it the cheesy covering of the skin. She keeps the baby's body covered except for the part under attention. She should first wash and wipe the baby's face and head, taking care not to get soap in the eyes. After washing any part she pats it dry, taking special pains to dry each fold and wrinkle of the skin. Sometimes the doctor will advise that the baby be cleansed only with oil at first and not bathed in water. If the baby is not in good condition this is always advisable and may be continued for several days. Oil cleanses the skin very well and conserves the body heat of the child.

The Cord.—The nurse dresses the cord as soon as cut by cutting a hole in a pad of sterile gauze, which she slips over the stump and covers with another piece of gauze. She bathes the baby and applies the band without touching or exposing the cord, if possible. If it has been exposed she sponges the cord with alcohol or other antiseptic, dries it carefully with dry, sterile gauze, applies a fresh dressing, and adjusts the baby's band. Grease or salve or powder of any kind should never be put on the cord.

To adjust the band it is placed under the baby, lapped smoothly in front, and pinned with small safety pins placed closely together,

[1] DeLee, Joseph, *Obstetrical Nursing*, pp. 203–205, 7th ed., W. B. Saunders Company; Samuel R. Meaker, *Mother and Unborn Child*, pp. 166–170, Williams & Wilkins Co., 1927; Bacon, *loc. cit.*, pp. 264–266.

[2] Van Blarcom, Carolyn, *Getting Ready to Be a Mother*, The Macmillan Company 1925; also Carolyn Van Blarcom, *Obstetrical Nursing*, The Macmillan Company, 1929.

beginning at the bottom. It should be pinned to fit the shape of the body, and fit without wrinkles; at the same time it must not be tight. With a plump, round baby it is sometimes necessary to pinch up little darts at the lower edge and fasten with small safety pins, placed closely together.

If the cord is dry and sterile when dressed, and if it can be kept dry, it should not need to be redressed until it comes off at the end of 6 or 7 days. The baby must not be put in a bath



FIG. 50.—Nursing the baby in bed.

until the cord drops off and the stump has healed. Of course it must receive a sponge bath every day. If there should be any discharge from the cord it must be redressed, and this condition should be reported to the doctor. After the cord drops off a pad of sterile gauze will be kept over the stump until it is entirely healed, when the pinned band will no longer be necessary. It is advisable to put only band (shirt, in cold weather), diaper, and nightgown on the baby for the first few days.

The First Nursing.—The baby should be put to both breasts for a few minutes as soon as the mother has had a sleep and feels

rested and ready. When the baby is brought to nurse the nipple should be washed with boric-acid solution or boiled water and dried with sterile cotton. The mother should turn on one side and have a pillow thrust firmly against her back to support her (see Fig. 50). If it is not desirable to have her turn completely on her side the baby may be placed on a pillow so that she will not have to twist her body. The nipple and breast should be kept dry and clean and covered at all times with a clean, sterile cloth or gauze, which may be held in place with adhesive strips laced together (Fig. 51). Common clothing, dust, hands, etc.,

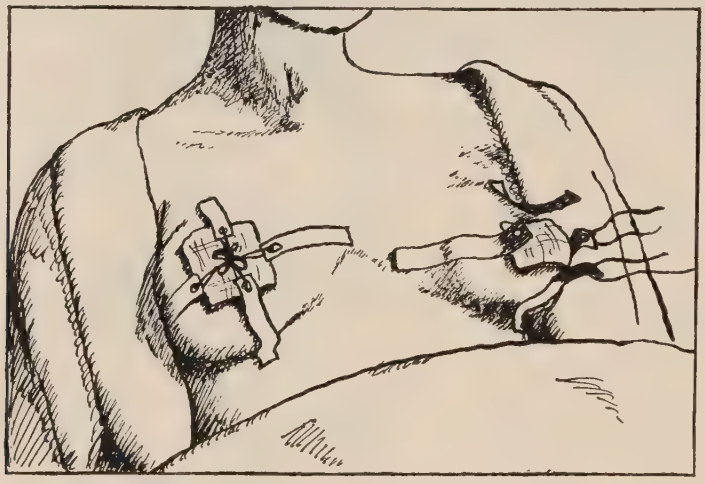


FIG. 51.—Proper care of the nipples.

always contain pus germs. It is very easy for these to set up activity in the very small abrasions in the tender nipple and cause infection. As much care should be taken with the breasts during the lying-in period as with any surgical wound.

The sucking of the child causes the uterus to contract, thus helping to prevent hemorrhage, and it stimulates the milk glands to activity. It is also desirable to call the nursing instinct into action reasonably soon, for it sometimes fades through delay. While there is no urgency in the matter it is desirable to put the baby to the breast as soon as the mother is fully rested, and quite regularly every 4 to 6 hours afterward (as directed by the physician), except during the night. *The baby should receive nothing except breast milk and warm boiled water at any time without orders from the attending physician.*

For the rest the newcomer will require only warmth from loose, porous, lightweight woolen coverings, and quiet. He

requires time to make his adjustments to the new order, and he spends his first hours or days somewhat as he has been accustomed to spend them—in warm and dreamless sleep.

Complications of the Puerperium. *Post-partum Hemorrhage.*—It has been stated that the uterus contracts like an overstretched rubber bag when emptied by the birth of the child. This is Nature's way of stopping the bleeding when the afterbirth comes away from the wall. The nurse should watch that the uterus does not relax while the patient is asleep or resting, as violent hemorrhage may set in. The nurse can usually arrest hemorrhage by grasping the uterus through the lax abdominal wall and kneading it rather vigorously. If it does not then draw up, a cold, wet cloth or piece of ice may be rubbed over this part of the abdomen. Putting the baby to the breast will nearly always make the uterus contract.

While the physician is coming the foot of the bed may be raised by placing a chair or other piece of furniture under it until the feet of the patient are considerably higher than the head. The baby should be kept at the breast and the nurse should continue kneading the uterus through the abdomen. If promptly and persistently carried out these measures will rarely fail. In very extreme cases the vagina may be firmly packed with strips of sterile gauze.

Puerperal Septicemia, Septic Infection, Childbed Fever.—Septic (pus) germs of many varieties are practically omnipresent.[1] They are unable to penetrate unbroken skin or mucous membrane, but grow with great readiness in living tissues if they gain entrance and if the immunity is low. The inside of the uterus immediately after the separation of the placenta is a very favorable place for the growth of septic germs. This is the reason so much emphasis is placed on having everything that comes near the vaginal entrance absolutely sterile.

Even though the doctor may be scrupulous about his own hands and instruments, the nurse may be careless in assisting him or fail to use sterile vulvar pads, or fail to keep these parts

[1] The most virulent type of infection is from the streptococcus hemolytica, the germ which causes fatal blood poisoning, scarlet fever, and erysipelas. Some success is reported from the use of streptococcus serum and even scarlet-fever serum in puerperal cases.

surgically clean, and germs may gain entrance after labor is ended. The immunity of the woman may be low because of her diet or general condition, and she may have foci of infection elsewhere in her body, in teeth, appendix, or sinuses.

The symptoms appear suddenly about 3 or 4 days after delivery. The patient complains of chilliness or has a chill, she complains of tenderness in the lower abdomen and feels ill, and her temperature rises. The attack may subside within a few hours or days in mild cases, or terminate fatally within a few days in severe streptococcus infection. Others drag along in a subacute form for a number of days with subsequent recovery. Occasionally septic material from the uterus lodges in a vein of one leg, causing "milk leg" (phlegmasia alba dolens). The leg affected swells, and septic fever may occur.

The infection may travel up the Fallopian tubes and, by shutting off the tiny openings with scar tissue, render the woman subsequently unable to become pregnant. It may reach the ovaries, or even the peritoneal lining of the abdomen, causing peritonitis, which is always serious and often fatal.

In spite of modern progress, childbed fever still leads on all lists as the chief cause of death among all causes related to pregnancy and childbearing. Skilled, modern obstetrical service and clean, intelligent nursing are even yet available to a relatively small number of the women of our country. Puerperal fever rarely occurs in hospitals or where modern nursing and medical care exist.

The situation will change in the degree in which women generally become intelligent and informed as to the importance of skilled care during the entire period of pregnancy and the puerperium. When women know what to expect in the way of medical and nursing care and become willing to go early to a thoroughly qualified physician and pay adequately for the service, and when women citizens see to it that no woman is forced to risk the life and health of herself and her child because of poverty —when these things come to pass, childbed fever and eclampsia will move from the top to the bottom of our mortality tables, and America's place in the international maternal mortality tables will become more creditable than it is at present, when

20 of the civilized countries have lower maternal mortality rates than does America.[1]

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[1] HARMON, G. E., Mortality from Puerperal Septicemia, *American Journal of Public Health*, June, 1931; RAND, SWEENEY, and VINCENT, *Growth and Development of the Young Child*, p. 149, W. B. Saunders Company, 1931.

Scherzo
Come, sprite, and dance! The sun is up,
The wind runs laughing down the sky
That brims with morning like a cup.
Sprite, we must race him,
We must chase him—
You and I!
And skim across the fuzzy heather—
You and joy and I together
Whirling by!

You merry little roll of fat!—
Made warm to kiss, and smooth to pat,
And round to toy with, like a cub;
To put one's nozzle in and rub
And breathe you in like breath of kine,
Like juice of vine,
That sets my morning heart a-tingling,
Dancing, jingling,
All the glad abandon mingling
Of wind and wine!

Sprite, you are love, and you are joy,
A happiness, a dream, a toy,
A god to laugh with,
Love to chaff with,
The sun come down in tangles gold,
The moon to kiss, and spring to hold.

There was a time once, long ago,
Long—oh, long since . . . I scarcely know . . .
Almost I had forgot . . .
There was a time when you were not,
You merry sprite, save as a strain,
The strange dull pain
Of green buds swelling
In warm, straight dwelling
That must burst to the April rain.
A little heavy I was then,
And dull—and glad to rest. And when
The travail came
In searing flame . . .
But, sprite, that was so long ago!—
A century!—I scarcely know.
Almost I had forgot
There was a time
When you were not.

So, little sprite, come dance with me!
The sun is up, the wind is free!
Come now and trip it,
Romp and skip it,
Earth is young and so are we.
Sprite, you and I will dance together
On the heather,
Glad with all the procreant earth,
With all the fruitage of the trees,
And golden pollen on the breeze,
With plants that bring the grain to birth,
With beast and bird,
Feathered and furred,
With youth and hope and life and love,
And joy thereof—
While we are part of all, we two—
For my glad burgeoning in you!

So, merry little roll of fat,
Made warm to kiss and smooth to pat
And round to toy with, like a cub,
To put one's nozzle in and rub,
My god to laugh with,
Love to chaff with,
Come and dance beneath the sky,
You and I!
Look out with those round wondering eyes,
And squirm, and gurgle—and grow wise!

EUNICE TIETJENS,
from *Body and Raiment*,
by permission of and special arrangement with Alfred A. Knopf, Inc., authorized publishers. From *Poetry*.



"You merry little roll of fat."

CHAPTER XVI

THE BABY'S FIRST YEAR

Getting Acquainted.—There is no more joyous human experience than getting acquainted with a new baby, providing the parents permit themselves to enjoy him and do not take him too seriously. This means that they will inform themselves as to approved care, lay out a carefully planned regimen, and proceed to treat him as a personality and with the same casual consideration with which a wise host treats a valued guest.

Above all the parents should agree as to both regimen and attitude. They should read together and talk together until they do see alike, and until they can be precise without being fussy. In event of differences of opinion which cannot be "talked out," an authority whom both respect should be consulted as referee. Nothing is so destructive to morale and efficiency as differences in domestic policy, particularly with reference to child rearing.

The modern science of human development tells us that every act of a child is significant; therefore we will not chide the parental pair if they do spend much time watching the marvels of his growth. We want them to do this happily but quietly, and without making him too much aware of their studious observation.

The poem placed at the beginning of this chapter was selected because it expresses the spirit of a parenthood which receives the child as a joyous companion, rather than as an object of anxious sentimental solicitude.[1] We hope the parents of the child who is the object of our study are going to find in him a perpetual

[1] Eunice Tietjens (Mrs. Cloyd Head) writes: "'The Bacchante to Her Babe' was written in spirit of revolt against what seems to me the unhealthy attitude so many mothers have towards their babies . . . P.S. The 'sprite' of this poem is now married." (Mrs. Head, of course, does not mean that the baby is to be considered literally "a toy" in the sense of a "plaything," but rather in the sense of something to be fully enjoyed.)

adventure, an unfolding romance, "continued in our next" from day to day.

Budgeting the Baby into the Day.—The first real temptation to worry, and probably the first cloud upon the joys of parenthood, comes when the trained help leave the young parents to their own devices. Under ideal conditions the mother gets about and assumes her regular duties only as fast as strength and inclination dictate. Sometimes, however, she comes back from the hospital and finds no one but herself to run the household and to do the necessary work, or, if she is confined at home, the nurse and household help may soon be dispensed with because of the cost, or leave because they have other engagements, and thus a critical situation arises. *Baby must have regular care and abundant breast milk, which depends directly upon the food, rest, mental attitude, and sleep of the mother.* Very radical adjustments may be necessary in both personal and family schedules in order to accomplish this. The baby must be budgeted into the day's routine, and the mother must make out a work schedule so planned and systematized that every necessary activity will have its time and place, and also so arranged that she herself will have regular and sufficient rest and sleep.

The Baby's Schedule.—The items of the schedule will depend upon the family breakfast hour and other meal hours, the number of breast feedings per day, and other variable factors. For an average family which has breakfast at 7:30, lunch at 12:30, and dinner at 6:30, and where the baby is on a 3-hour feeding schedule, in which the mother does all the work for a five-room house or apartment except the weekly cleaning and heavy laundry, the average daily schedule would probably run somewhat as follows:

6:00 A. M.	Nurse baby while in bed.
6:30	Rise, bathe, dress, prepare breakfast.
7:15– 7:30	Eat breakfast.
7:30– 8:30	Do morning kitchen work, plan meals.
8:30– 9:00	Prepare bath, bathe baby.
9:00– 9:20	Lie down and nurse baby.
9:20–10:00	Tidy up rest of house, make beds, etc.
10:00–10:30	Wash baby's diapers and other clothes.
10:30–11:00	Read mail, get out of doors.
11:00–12:00	Prepare lunch, also dessert and vegetables for dinner.

12:00–12:20	Lie down and nurse baby.
12:20–12:30	Put lunch on table.
12:30– 1:00	Eat lunch.
1:00– 1:30	Clear table and wash dishes.
1:30– 3:00	Rest, make afternoon toilet, wheel baby out of doors, go to market, etc.
3:00– 3:20	Lie down and nurse baby.
3:20– 5:00	Varied employment—ironing, sewing, gardening, calling, etc.
5:00– 5:45	Prepare dinner.
5:45– 6:00	Prepare baby for night.
6:00– 6:20	Lie down and nurse baby.
6:20– 6:30	Serve dinner.
6:30– 7:00	Eat dinner.
7:00– 7:30	Father and mother wash dishes.
7:30– 9:00	Evening pleasures.
9:00– 9:30	Prepare for bed; nurse baby.

The diaper should be changed when necessary. The baby should also be offered water several times during the day, and his position changed occasionally. The very young baby sleeps most of the time, so there really is little to do for him except the routine items mentioned. As he grows older and becomes active and playful he will require more attention.

According to the above schedule, 2 hours are required for six 20-minute periods of nursing. If the mother lies down in a relaxed position, as she should do, this total of two hours' rest will conserve her strength greatly. In addition to this time at least another 2 hours will be consumed with the baby's bath, laundry, changing diapers, etc. If time is spent in wheeling the baby out, this must be added. However, the only excuse for this is that the mother herself gets out into the sun and air. As far as the baby is concerned, the buggy or basket may, and should, be placed in a favorable spot on porch or lawn without waiting for the mother's leisure.

Mrs. Lucille Rust of the Kansas State Agricultural College has made an investigation of the time actually consumed in the care of infants under one year of age, all of whom were receiving modern standard care. She found the average daily time spent by the mother and helpers in the care of these infants to be 5 hours and 20 minutes, averaging less for younger than for older children, while the fathers included in the investigation spent a total average of 18.6 minutes per child per day. She found the

number of times diapers were changed averaged 8. The younger mothers spent more time than mothers having other children.[1]

The above schedule does not make unreasonable demands upon the time or strength of any normal, healthy woman. The period of strain is the first day and the first week when this new routine is getting under way. The new mother feels tense and possibly worried lest she should not be able to meet the needs of the situation. She becomes too tired the first day; this reacts upon the milk flow; the baby is not satisfied and frets. Neither mother nor babe sleeps well and the next day is made difficult. The mother has less appetite and the baby more, a situation which may go on piling up fatigue for the mother and nutritional upset for the baby if the cause is not recognized and the proper adjustments made. *All of this can be much more easily prevented than corrected.* The new father is usually willing and anxious to be helpful during the first days of adjustment, and he will usually be glad to get the breakfast. The dishes may all be scraped and covered and left until evening when "Father" will help do them. Usually a high-school girl can be secured to assist after school. She can do the baby's washing and help with the dinner and the dishes. The regular schedule of the baby and the mother's health must have the right of way, but this must not entail confusion and disorder and the piling up of work and worry for the future.

The adjustments of the first week of the mother's return to her daily activities determine in the great majority of instances whether or not the baby will be a good baby. He will be a good baby and a healthy baby if he is placed upon a schedule which is perfectly adjusted to his own individual needs and if nothing is permitted to interfere with the rhythm of this schedule after his organs, nerves, and glands have set themselves, like well-adjusted clockwork, to the regular program.

After-care of the Baby.—As has been said, the baby is not finished when born, and for some time following birth he needs much the same conditions, in somewhat different form, that he enjoyed in his mother's body, *viz.*, warmth, oxygen, food, and quiet. Warmth he must get from light, woolen wraps, which

[1] Rust, Lucille Osborn, *A Time Study of Infant Care*, unpublished thesis, Kansas State Agricultural College, 1925.

should never be tightly wrapped around him. Loosely woven woolen is best, as he needs air, and fresh air, all about him. The oxygen he formerly received from his mother's blood he must now get from fresh, clean air. His food he must still get from his mother's body, but in a form especially adapted to his new state. *For the rest he wishes only to be let alone.*

Breast Feeding.—With very, very few exceptions, every mother *can* nurse her baby. With almost no exception, every mother *should* nurse her baby. The few instances in which the mother is so diseased or out of health that she cannot or should not nurse her baby are so rare that they may almost be ruled out of consideration. Artificial feeding should certainly never be resorted to without explicit orders from the attending physician.

Reasons Why Every Mother Should Nurse Her Child.—1. The sucking at the breast stimulates the uterus to contract, prevents hemorrhage, makes the uterus return more rapidly to normal size, and causes it to drain effectively and thoroughly.

2. The mother who nurses her baby will be less likely to have "female trouble" and premature return of menstruation.

3. Nursing a child is one of the richest spiritual experiences which comes to any woman, and no normal woman could wish to miss it.

Reasons Why Every Baby Should Be Breast-fed.—1. Mother's milk is the one and only food prepared by nature for the exact and particular needs of the human baby. *No perfect substitute has yet been devised.*

2. Mother's milk is always sweet and clean and cannot become contaminated by any of the dozens of ways in which artificial food may become unsafe.

3. It is always the right temperature.

4. *It belongs to the baby.* It is his food prepared at this time for his special personal use. No mother who realizes what she is doing will take the one rich, right, and suitable food out of her baby's mouth and substitute an uncertain imitation if it can be avoided.

5. More bottle-fed babies die in proportion than do breast-fed babies. This is not so true in the case of modern pediatric feeding, but even the best specialists have many problem cases because of the difficulties in successfully replacing breast milk.

Feeding during the First Three Days.—The baby's stomach and bowels are not ready for milk for several days after it is born. The mother's breast contains a fluid (colostrum) which is just what the baby needs to clean out his digestive tract and make it ready to digest milk. Colostrum contains no curd or casein, but it does contain minerals and sugar and some fat and probably some protective antibodies. It is a serious mistake to give the baby anything else except a little boiled water before the milk flow starts, unless ordered by the physician. Nature has made no mistake in delaying this for two or three days. Nurses, aunts, and grandmothers who give the baby sweetened water, catnip tea, milk, etc., make serious and sometimes fatal mistakes in so doing.

Before the milk flow starts, the baby should be put to the breast regularly every 4 to 6 hours during the day as directed by the physician. If mother and baby rest well it need not nurse at all at night; surely not more than once. Dr. Wayne Rupe says, "Put the new-born baby to the breast within 4 to 6 hours and every 4 hours thereafter."[1]

Causes for Delayed or Insufficient Milk Supply.—(1) Severe labor and delayed convalescence; (2) worry, loss of sleep, nervous excitement; (3) too hard work before confinement; (4) getting up too soon and working too hard after confinement; (5) insufficient or improper diet during pregnancy and lactation; (6) glandular imbalance. Rest, quiet, sleep, and careful feeding will overcome the effect of all these causes in most cases.

If the lying-in mother does not have proper rest, sleep, or food, so that her body can manufacture good milk, sometimes Nature protects the baby, and the tired, undernourished mother makes good milk, but becomes run down and loses weight and strength herself. Sometimes Nature protects the mother and takes the shortage out of the baby's milk supply. Either situation is a tragic mistake. Sometimes the opposite situation occurs, and the mother overeats in an excess of zeal and in a conscientious endeavor to carry out everybody's suggestions as to what she should eat and drink. She naturally develops indigestion, during which she cannot eat. The rest of both mother and babe is broken. Everything is upset. The flow of milk slackens; the

[1] RUPE, WAYNE, *Lectures on Pediatrics*, University of Kansas, 1928.

baby is fretful and loses weight. The neighborhood and family council may decide that the milk does not agree with the baby and that there is not enough of it, and sometimes a sequence of blundering experiments follows, during which a perfectly good baby may be ruined in health and disposition and the mother's health impaired.

The young mother often makes too hard work of caring for herself and her babe. She needs only to practice the simple general laws of health, including regularity, a balance in sleep, exercise, and food, keep serene, and turn a deaf ear to neighborhood council!

Other Causes for Failure to Nurse a Child.—(1) Sore breasts; (2) inverted nipples; (3) baby refuses to nurse; (4) milk disagrees with baby. The first and second causes may be prevented, in part at least, by proper treatment of the nipples before confinement and at the beginning of nursing.

If the nipples do become excessively tender and the baby sucks vigorously it may become necessary for a short time to draw the milk with a breast pump and give it to the baby in a bottle or with a medicine dropper. During the first three days of life the time of each nursing should be limited to a few minutes. The baby should not draw on an empty breast, as this bruises it unnecessarily. A nipple shield is sometimes successfully used when the nipple becomes sore. This is a mask made of rubber, lead, or glass which fits over the nipple and protects it somewhat from the terrific squeezing of the baby's sucking muscles, which, any mother will agree, are the strongest muscles in its body. The nipples should be kept clean, dry, and sterile (see page 266).

If the baby refuses to nurse it may be the fault of the attendant. The baby will practically always nurse if put to the breast promptly and regularly. The nursing instinct is very strong at birth, but may fade if not used. If a baby has not been put to the breast reasonably soon after birth it is sometimes very hard to teach him to nurse. Squeezing a few drops of milk from the nipple will sometimes bait him to grasp it. Giving the baby sweetened water or other liquid before placing him at the breast may be the cause for his refusal.

Very rarely it happens that a baby is born tongue-tied and cannot nurse. If there is any suspicion that he cannot nurse

rather than that he will not, he should be examined by the physician.

If the Milk Disagrees.—As for the fourth reason for failure to nurse the baby, it is very, very seldom that a mother's milk disagrees with a baby for more than very temporary reasons, such as indigestion, anger, nervous excitement, etc., on the part of the mother, or still more rarely, in case of actual illness of the mother. Nature protects the baby in many wonderful ways, and one of these is that the mother's milk remains unchanged through many kinds of severe illness. Very rarely the mother's milk may lack proper balance in protein, carbohydrate, or fat. The child's symptoms and the analysis of the milk will clarify this, and adjustment of the mother's diet will usually correct it.

Sensitization.—Once in a long time a baby is "sensitized" to some protein in the mother's diet. By "skin tests" it is now possible to find whether sensitization exists and what the article of food is which disagrees. This may be eggs, beef, berries, etc. When this condition exists the indigestion will be promptly relieved by omitting the harmful article from the mother's diet. The matter is one for careful medical diagnosis. No mother should experiment with her diet or that of the child.

Intervals between Breast Feedings.—The doctor should always be asked how often the baby should be fed from the time the milk flow comes. A weak, delicate baby will need to be fed oftener than a strong one because it cannot take so much or digest so much at one time. When the baby is hearty and strong most physicians recommend feeding not oftener than every 3 hours, and some advocate 3½- to 4-hour intervals from the start.[1]

No baby should be fed oftener than once during the night, and many do well with no night feeding from the outset.

A good 3-hour schedule is 6, 9, 12, 3, 6, 9 with one feeding about 2 A. M. if necessary for the first 6 or 8 weeks. At about eight weeks the night feeding may usually be dropped and the interval between the feedings gradually lengthened until at six months the schedule is 6, 10, 2, 6, 10.

Length of Time at Breast.—A good deal of positive advice has been given to the effect that no baby should be permitted to

[1] BACON, CHARLES SUMNER, *Obstetrical Nursing*, p. 311, Lea & Febiger, 1924.

nurse longer than 20 minutes at a feeding. As a matter of fact, few things require more common sense and careful judgment than this, and each baby should be individually studied. As a rule, if the 3- or 4-hour period is observed the baby should nurse as long as he wants. If he has not been spoiled he will be the best judge as to when he has had enough. There is so much difference in the rate of flow of milk, size of nipple openings, and nursing grasp of the child that it is manifestly unjust to say that all babes should nurse for the same number of minutes. The child should be kept awake and busy and not permitted to sleep or idle at the breast. As a matter of fact, it never takes a normal child 20 minutes to fill his stomach. Usually he will be satisfied within 10 minutes.[1] If he clings to the nipple this long he is not satisfied and it should be determined as to whether or not he is getting a sufficient amount of milk.

Most physicians now favor longer intervals between feedings and longer periods of nursing than was customary a few years ago. *But this must be carefully adapted* to the individual child. It must always be remembered, whatever the interval, that the baby must be fed regularly and that its stomach must have some rest between each two feedings.

Water is as important as food. Cool (not cold) boiled water should be offered to the baby between feedings at least twice per day and during very hot weather between each two feedings during the heat of the day.

How to Nurse the Baby.—The busy mother should always lie down to nurse her baby. The baby should be placed so he can breathe easily and not be crowded. The mother should have a pillow against her back and utterly relax. *Twenty minutes of absolute rest every 3 hours will do much to conserve her strength.* If the mother sits she should use a low, comfortable chair. A pillow on the lap enables a woman to sit up straight and without strain while holding a baby at the breast.

How to Tell How Much Milk the Baby Is Getting.—The baby may be weighed just before and just after each nursing for one full day, using a scale which weighs accurately in ounces and fractions of an ounce. Each amount should be recorded and all

[1] The Duration of Breast-milk Feedings, *Journal of the American Medical Association,* Jan. 13, 1923.

added together. An ounce of milk by measure weighs about an ounce. The total amount should be approximately the same as that allowed for artificial feeding, on page 324.

How to Check the Milk Supply.—If the baby does not take all the milk, and the breasts become painfully full, or if the baby dies, or for any reason it is desirable to check or stop the flow, a binder should be snugly applied and the milk should be drawn or expressed from the breasts just often enough to prevent them from "caking" or becoming sore, and just enough at a time to give relief. Often it will not be necessary to touch the breasts, as the flow tends promptly to lessen and within a few days will entirely cease. This should always be done under the direction of a physician, as certain drugs may be indicated.

To Express Milk from the Breasts.—The operator should scrub the hands thoroughly with hot water, soap, and brush. The operator sits facing the mother, who may either lie or sit as she prefers. The hands are placed about the breast with the thumbs passing each other below the nipple. *The nipple should not be touched at any time.* The breasts are rolled with a flexible, gentle pressure, working from the base to the apex of the breast. The operator should not hurry and should not pinch or squeeze, but use the greatest gentleness and patience. If it is desired to save the milk for the baby a second person or the mother must assist by holding a sterile cup under the nipple to catch the milk. This can be fed to the baby with a medicine dropper or from a nursing bottle.

The Baby's Toilet. *The Bath.*—The baby should be bathed at a regular time daily. Just before the second feeding is usually the most convenient time. He may have a daily tub bath as soon as the navel is healed.

A foot-tub or infant's bathtub or oval dishpan should be used with a folded towel over the bottom to keep the baby from slipping. A low table is more convenient than the lap for handling the baby although some mothers prefer to handle the baby on the lap. If the table is used, one end of it should be padded with a heavy bath towel or folded quilt or other soft pad. The tub is placed on the other end (the left if the mother is right-handed) of the table. If the mother finds it more convenient to handle the baby on her lap, she should wear a rubber apron

and spread a large bath towel over her lap and place the tub on a stool, chair, or low table in front of her. On a chair or stool near by is placed the toilet tray or basket, containing soap, boric acid for the eyes, vaseline for the nose, the glass of sterile cotton swabs on toothpicks, talcum powder, etc. On the drying rack, also near by, should be hung the baby's washcloth, face towel, and clean clothes. The toilet of the head should be made first, then the toilet of the genitals and navel. Small bits of sterile cotton or gauze should be used and discarded as used. In the male child the foreskin should be retracted and secretions gently removed. In the girl child the labia should be separated and the parts cleansed with cotton.

Care of Eyes, Nose, and Ears.—The baby's eyes should be cleansed with pledgets of cotton or sterile gauze wet in boric acid or boiled water. *A separate piece is used for each eye and thrown away.* The eye should be wiped from the inner corner toward the outer corner, without forcing the eye to open.

The baby's nose should be let alone unless there is some discharge or inflammation. Then the nostrils are cleansed very gently with cotton swabs on toothpicks, or twisted pledgets of gauze or cotton dipped in sterile vaseline or oil. The cotton must extend well beyond the end of the toothpick and the swab should not be large enough to require force in inserting it in the nostril. Force must never be used and no preparation should be put in an infant's nose other than plain sterile oil or vaseline, without a doctor's orders. Infants sometimes show undesirable reactions to nasal preparations containing menthol, eucalyptus, and other drugs which are used with benefit by adults and older children.

The external ear should be cleansed very carefully with a toothpick swab dipped in clean water and dried with a dry bit of cotton. *One should never attempt to cleanse the inside of the ear canal.*[1]

[1] A doctor should be consulted immediately if the baby shows any sign of trouble with eyes or ears. It is better to do this many times for simple troubles than to neglect a serious condition once. It is a terrible thing to go through life with defective sight or hearing because of early neglect.

A doctor should also be consulted, a specialist if possible, if the baby does not breathe freely and easily through its nose. This may mean enlarged adenoids, even in very early infancy.

The scalp is next soaped and rinsed and dried very thoroughly but gently. The baby's scalp should be bathed daily, as sebaceous secretions easily collect and form the so-called "scale" or "cradle-cap." If scale should occur sterile vaseline may be rubbed on at night and shampooed in the morning. This scale should never be "combed off" for this irritates the scalp and may provide entrance for infective germs. If this treatment does not suffice the physician should be consulted, as a scalp infection may be present. The hair may be arranged with soft brush and infant's comb.

The face is then gently washed with very soft cloth and thoroughly dried. It will seldom or never be necessary to use soap on the face.

The body is now soaped. The mother then takes the baby on the left arm, letting the buttocks rest in the palm and the back and head rest on the forearm and lowers him gently into the water. With the right hand and washcloth she washes off the lather; places the baby on the wiping towel, folds this over him, and pats him dry. She should then take plenty of time to go over his body, gently drying every fold and wrinkle, even between the toes and fingers. This will do more than any other one thing to prevent chafing.

The mother may massage the baby's body by gently rolling the flesh with the palm of the hand. If this is properly done the baby will thoroughly enjoy it. It stimulates the circulation and tends to make the baby more resistant to taking cold. The baby should, if possible, lie and kick for a few moments either before the bath or before dressing.

Powder need be used but sparingly if at all except in very hot weather. A very little good powder may be used but no more than can be "rubbed in." Loose powder should never be left in wrinkles, since this is irritating.

The region of the anus should be carefully bathed and dried after every bowel movement. If there is any redness or irritation a little "sweet oil," vaseline, or other lubricant should be applied.

Dressing the Baby.—To dress the baby, adjust the diaper, shirt, and stockings. Pin these together so that they will be smooth but not tight, and also so they will stay in place and not wrinkle



FIG. 52.—The diaper should be folded square and put on so that it will give perfect freedom. (*Courtesy Kansas State Board of Health.*)



FIG. 53.—(*a*) Baby with improperly adjusted clothes. (*b*) Baby with diaper, knitted band and stockings properly adjusted. (*Courtesy Kansas State Board of Health.*)

and draw. The diaper should be folded square or oblong, never three-cornered (see Figs. 52 and 53).

If the garments open only part way, place the skirt inside of the dress, run the left hand through from the bottom to the neck; lift the baby in the crook of the right arm and slip his body, feet first, into the dress through the neck if large enough, grasping his feet with the left hand, then putting the arms into the sleeves as they come to them. Never put garments on over a baby's head if it can be avoided, and never force sleeves on by bending

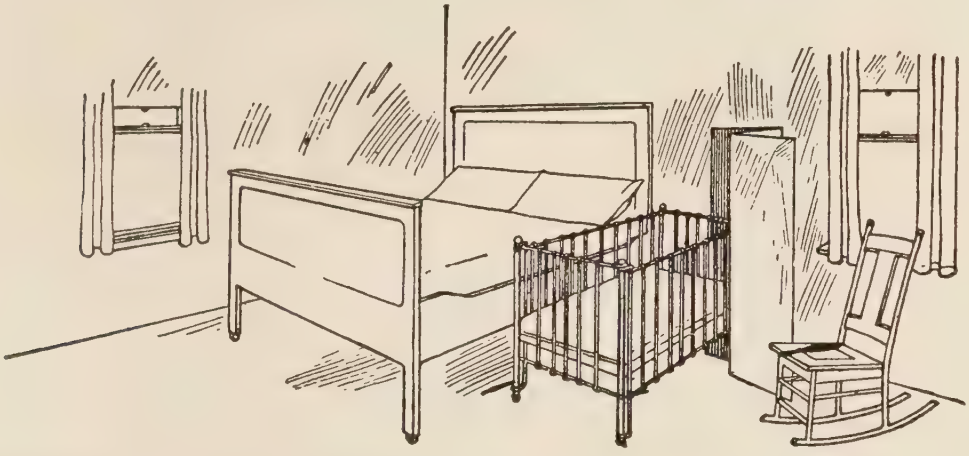


FIG. 54.—Proper arrangement of mother's and baby's beds. (*Courtesy Kansas State Board of Health.*)

the arm backward. If all garments open down front, telescope everything on the table and lay the baby on them and fasten (see Fig. 214).

The Baby's Bed. *The Baby Should Sleep Alone from the Very Start.*—It is both dangerous and insanitary for a baby to sleep with an adult. It is much better to place the baby in a common clothes basket on a chair by the side of the mother's bed, or in a box, if a bassinet has not been provided (Fig. 47). At about six to eight months the baby outgrows the bassinet and it is better to use a child's bed. This may be large enough to be used until the child is ready for youth's or adult's bed.

To Protect the Baby on Cold Nights.—Half of a woolen blanket may be sewed to make a square bag. A round hole is cut in the center of one end for the neck; the middle of the front is cut and bound on the edges. It may be tied with strings or pinned with safety pins. It should be very large so the baby can move his arms and legs and turn as he likes.

After his night toilet is made he is tied in this sleeping bag. If the room becomes very cold a hood should be put on *when it begins to get cold, not before.* In extremely cold weather a folded blanket may be spread over the basket, the baby placed, sleeping bag and all, in the middle; the blanket is folded over this *loosely* and pinned at the shoulders with safety pins. *Never*

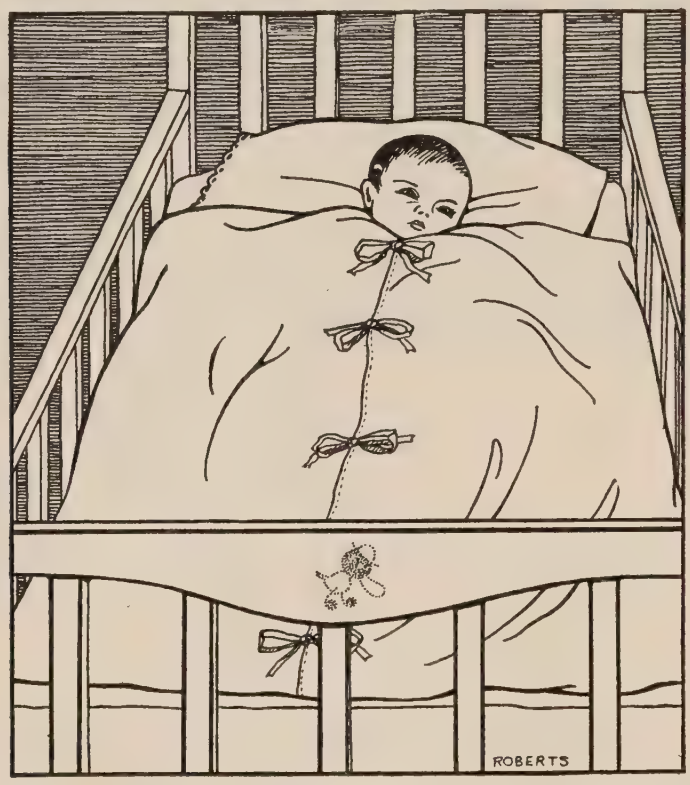


FIG. 55.—Infant in sleeping bag.

"tuck in" a child of any age so tightly that he cannot turn or move freely. Children will not kick off the covers if they are free and comfortable.

Changing Diapers at Night.—During the first few weeks of life, or during illness, there should be a warm place to take the baby to change it, although it need not sleep in a warm room. If the mother must get up one or more times, her comfort and safety from exposure make it necessary to keep the night temperature from dropping too low. After the feeding is regulated the infant's bowels should not move at night. During cold weather it may be better to place extra diapers *under* the baby to absorb the urine, and not expose it to remove wet diapers during the night. However, a child who awakens when wet and

demands a change from the start is less likely to become a "bed-wetter." He may be more trouble at first, but he will be less trouble later. The mother must decide upon her policy in the matter according to heating conditions in her house and the exposure entailed to the child and herself.

Sleeping Habits.—The new baby sleeps almost all the time. It should be wakened regularly to nurse during the day. In a short time a habit will be formed and the baby will awaken and demand food with almost clock-like regularity. If this is not done he will not get food enough during the daytime and will have to nurse at night. It is very important that the mother should have unbroken sleep; so great pains should be taken by the nurse before she leaves to have the baby trained to feed regularly during the day and sleep at night, and the family should cooperate in this.

As soon as possible, according to the weather and other conditions, the baby should be put out of doors for his daytime naps. He should be dressed exactly as if he were to be taken down town or elsewhere. The buggy is permitted to stand outside while he sleeps. He may be in the sun for part of the time (see page 394), when not too hot. *Always shade the eyes from direct light and shield from wind and dust.*

The Baby Is Not a Plaything.—The interest of family and friends naturally centers in the wonderful new baby. Everyone "wants to hold him." After he begins to take notice, everyone "loves to make him laugh," and some persons will even thoughtlessly tickle or shake or otherwise excite a baby for the pleasure of hearing its violent laughter. *This is all wrong and must not be permitted.* Babies need to have the position changed often, and they may be occasionally carried from place to place for changes of scene and variation of experience, and mothers are now again permitted to have the pleasure of holding their infants occasionally. As babies grow older they should be quietly amused and provided with an abundance of occupation. Violent play or tossing or shaking should never be permitted. Lifelong suffering from nervousness may result.

Thumb Sucking.—Like most habits, thumb sucking is more easily prevented than stopped. Practically every baby sucks thumb or fist during periods of feeding adjustment when he

happens while hungry to get his thumb in or against his mouth. Because he stops crying and seems comforted for a time the mother is apt not to realize the importance of seeing to it that repetition does not establish a distressing habit. The thumb should be quietly removed from the mouth the *first time and every time* the baby is observed to put it in his mouth. If he is persistent the sleeve may be pinned to his clothing in such a way as not to interfere with free movement and still prevent his reaching his mouth.

After the habit has become fixed the mother must be very persistent and never give up after she has undertaken to break it. It is important that all measures be carried out quietly and casually, remembering that it is "fading through disuse" that must be accomplished. Dramatization and violence only intensify and prolong the habit. Keeping the child happily employed is important; the child tends to suck his thumb when he has nothing more interesting to do. Measures of restraint must not limit the child's activity nor be permitted to become irritating. Many children suck the thumb only or chiefly when going to sleep. Giving the child something interesting to hold, or quietly removing it while telling a bedtime story may be effective. Violent "cures" can easily become more injurious than the "disease." The cooperation of older children may readily be enlisted if an attitude of negativism has not been established by coercion.

Thumb sucking deforms the arch and the teeth, and encourages the development of enlarged tonsils and adenoids. Some authorities think it even stimulates the sex organs undesirably. There is plenty of reason other than this, however, for handling the situation promptly. Recent research seems to show that deformities of the temporary teeth from thumb sucking tend to correct themselves and not to affect the permanent teeth unless prolonged until the permanent teeth begin to come through.[1]

The Baby's Bowels.—The first movements (meconium) are dark colored and of a smooth, viscid consistency and consist of

[1] Heering, Gertrude A., A Study of Thumb Sucking in Infants from Two to Seventeen Weeks of Age, *Child Development*, September, 1932; also Lewis and Lehman, Observation in Growth Changes of the Teeth and Dental Arches, *Dental Cosmos*, May, 1929.

the material which accumulates in the bowel before the baby is born. The *colostrum* in the mother's breasts during the first two days cleans this out of the bowel. Until this is done it is usually a mistake to put anything in the baby's stomach which must be digested.

The bowel movements soon turn yellow after milk feeding starts, and should have a smooth, mushy consistency. The normal baby usually has from two to four movements in 24 hours, although some very early lessen these to one. The important thing is that there shall be regular and sufficient elimination of food waste. A baby which is fed regularly, sleeps regularly, and is bathed regularly soon comes to have regular bowel movements. Nothing is more important than that regularity should early be established in this respect.

At six to eight weeks a mother may begin training the infant in this respect, and many modern mothers begin almost from birth. Small vessels can be purchased wherever crockery or toilet articles are sold. The mother warms the vessel, holds it on her lap, and seats the baby on it in such a way that the baby is comfortably supported in the crook of her arm. By doing this regularly during or following the early morning feeding, or following the feeding after the bath, and again after the evening feeding, 12 hours later, it will become increasingly possible to eliminate soiled diapers. Careful watching and making a schedule of the normal urinations will make it possible to reduce the number of wet diapers. A child who is thus trained to be dry and clean will be far less liable to become an habitual bed-wetter, and will be a more comfortable, sanitary, and satisfactory child.

Signs of Bowel Trouble.—Undigested milk curds, mucous clots or shreds, greenish or watery stools, or too frequent stools, indicate indigestion or infection. The treatment is immediately to stop giving milk if the condition is acute, or reduce the amount if the symptoms are not severe. One teaspoonful of castor oil for an infant, or two or three if the child is a year old or older, or a teaspoonful or more of milk of magnesia may be given. All the cool, boiled water the child will take should be given him. If the discharges are irritating an injection of one pint of warm boiled water in which one level teaspoonful of salt and one-half

teaspoonful of soda have been dissolved may be used. This should be very slowly and gently given. After each movement of the bowels the anus and buttocks should be washed with soap and water, patted dry with a soft cloth and anointed thoroughly with vaseline, lanoline, cold cream, or sweet oil. If the condition is not improved within a few hours, or if fever occurs, a physician should be consulted at once.

Constipation.—When a breast-fed baby becomes constipated the mother should carefully regulate her own diet by eating an abundance of laxative food and drinking plenty of water. The baby should be given boiled water 30 minutes or so before several successive feedings. A constipated baby is often given an ounce of thin strained oatmeal gruel before one feeding each day. Some pediatricians give sorghum in teaspoonful doses (see page 338). Prune juice is sometimes given for its laxative effect. The physician should be consulted as to these measures.

Immediate Relief for Constipation.—A child who has missed having his regular movement should have the colon emptied before being put to bed. For the small infant the oil enema is the best first aid. A soft rubber ear syringe or infant syringe may be used, or, better still, a soft rubber catheter the size of a small lead pencil, with a small funnel fitted into the open end. Four to eight ounces (according to the size and age of the child) of olive oil, sweet oil, or good cottonseed oil, or any salad oil, is placed in a cup and the cup set in hot water until the oil is warm. The infant is placed on its left side with its knees drawn up on its abdomen. The syringe full of the warm oil is very gently and slowly injected into the bowel; the diaper is held over the anus for a moment or two and the baby is kept quiet until the bowels move. The oil may be retained for sometime, even all night, and very thorough evacuation follows.

If the catheter (soft rubber tube) is used it should be oiled and gently inserted with a twisting, corkscrew movement, so that the end of the tube cannot remain caught in a pocket of the loose, wrinkled mucous lining of the bowel. The tube may be inserted from 3 to 4 inches. No force whatever should be used in introducing anything into a baby's bowel. After the tube is in place the oil is poured slowly through the funnel. The tube is slowly withdrawn and something held over the anus as directed above.

Soapsuds made of warm, soft water and bland soap, or warm water with a pinch of salt, may be used instead of oil.

Cautions.—A baby should never be given more than one dose of laxative without a doctor's orders, as repeated doses of castor oil or any other cathartic cause constipation instead of relieving it.

The mother should make an earnest study of trying to regulate the baby's bowels without giving laxative medicines. It is one of the most unfortunate things which can happen to have the

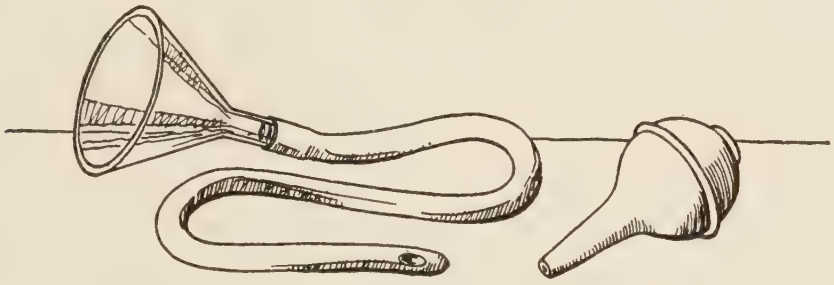


FIG. 56.—Equipment for giving oil or other fluid by bowel.

regular rhythm of the baby's bowels chronically upset, thus establishing an early "cathartic habit."

The muscles of the bowel contract with worm-like, peristaltic movement when the stomach begins to churn its food. This is why a few moments after eating is the natural time for the bowels to move. The muscles soon become trained to act at a certain time with clock-like regularity, although the rhythmic interval varies in different individuals and is influenced by diet and activity. Nothing should ever interfere with the regularity of the day's feeding, and the bowels should become perfectly regular also, although they may move one, two, or three times. *Glycerine suppositories or "soap sticks," "paper spills" or irritants of any kind should not be used with an infant.* Plain, unmedicated cocoa butter or gelatin suppositories may be used as emergency relief. The rectum is a highly specialized, highly sensitive organ which should be protected as much as the eye or mouth. There is no doubt but that lasting injury sometimes follows the meddling use of irritants and cathartics, which have a reactionary effect and tend to establish constipation if frequently repeated.

Diapers.—It will minimize the unpleasantness of caring for the baby's diapers if a square of soft old linen or a very soft paper napkin (sold in most 10-cent stores at 50 for 5 cents), or a pad of the even softer toilet tissues or paper handkerchiefs is placed inside the diaper to receive the bowel movement.[1] The filler can then be burned, and the diaper is much more easily washed. This is especially desirable during the first week, as the first bowel movements are dark and stain the diaper.

Washing Diapers.—A jar with a tight cover should be used to receive the soiled diapers, and they should be covered with cold water, after all loose bowel movement has been removed with newspaper and burned. Soiled diapers may be held firmly by one corner and rinsed by flushing the toilet several times, then placed in the jar of water. They will wash more easily if not allowed to dry. They should be sudsed, boiled, dried, and ironed in the regular manner. *Wet diapers should always be scalded and dried before using again.* Diapers should be dried in the sun if possible, and should be ironed unless the material is very soft. Lye, strong soap, bleaching powder, or any strong chemical should not be used on the diapers. Mild soap and hot water are sufficient. They should be thoroughly rinsed.

Crying.—A healthy, happy, comfortable baby does not cry more than necessary to state his needs. When a baby cries he has something to cry about, and it is the mother's business to find out the reason. The theory that a baby needs to do a certain amount of crying in order to thrive is dangerous and may easily lead a young mother seriously to neglect her baby. Babies may cry for the following reasons:

1. *Because They Are Tired.*—Some people say that babies soon learn to cry to be taken up, and that they should be disciplined and left to "cry it out" until they drop to sleep with exhaustion. This notion ascribes more intelligence to the new-born babe than most psychologists will allow. If mothers would remember that the baby needs to have its position changed often and its clothing straightened in order that its tender muscles and skin may not actually suffer, there would be much less crying and so-called "temper" in babies. Frequently they become tired because they

[1] Very soft tissue-paper pads or "diaper fillers" for this purpose are now on the market, produced by a well-known paper house.

are tucked in too tightly or pinned up so they cannot move. It is more scientific to find out *why* a baby likes to be taken up than to assume that he is "spoiled" and is having a "temper tantrum." Since restraint of movement is about the only cause assigned for the infantile "rage," it is wise to see if he does not have a normal urge to move some part of his body and cannot do so. When he is taken up his discomfort is relieved. This is all he asks! He may also be tired and hypersensitive because he has been overstimulated and handled too much. A strict reorganization of method is the only answer to this.

2. *Because Bands Become Tight and Clothing Rubs or Chafes or Pins Prick.*—Every effort should be made to prevent the baby's clothing from annoying or fretting him, and it should be loose enough to permit him to move freely.

3. *Because His Sleep Has Been Disturbed.*—A baby whose sleep has been disturbed will be fretful, tired, and justly cross.

4. *Because of distress in stomach and bowels* which may be caused by the various conditions mentioned elsewhere.

5. *Because He Is Hungry.*—A perfectly good reason, but the mother should be quite sure this is the reason. Children often cry because of *thirst*, which should always be thought of as a possible cause of discomfort.

6. *Because He Is Sick.*—The sick baby appears heavy-eyed and listless and whimpers rather than cries. A low, plaintive wail marks the very sick child. A child in acute pain, such as earache, cries out suddenly, is apt to turn the head back and forth, and an older infant will grasp at the painful region.

A Baby Does Not Need to "Cry for Exercise."—He had better crow and kick and laugh. The mother should strive to understand the things her baby is telling her, even though her advisers say "let him cry," because he "has no language but a cry."

Indigestion or "Colic."—To take a baby from the breast and put it on artificial food because it has colic, or indigestion, or loses weight, is usually unnecessary and often a very serious mistake. All efforts should be directed to building up the mother's health, obtaining more sleep and rest for her, getting mother and babe out of doors, paying close attention to regularity and manner of nursing and, especially, giving careful attention to the mother's diet. The mother must help herself by self-

control and careful regulation of her daily life. It should always be borne in mind that indigestion may be caused by many reasons other than the quality of the mother's milk. The commonest of these are the following:

1. *Tampering with the Baby's Stomach by Feeding It before the Mother's Milk Comes.*—It cannot be repeated with too much emphasis that *the baby should receive nothing but boiled water and breast milk unless ordered by the attending physician.*

2. *Irregular Feeding or Too Frequent Feeding.*—This is a common cause of indigestion. The stomach of the infant who is nursed every time he wiggles or shows any sign of life not only never has a chance to rest, but it actually has several batches of food in it at the same time: fresh milk, and milk curds in various stages of digestion. This is a certain way to produce indigestion and colic. Even regular 2-hour feeding does not give the average infant time properly to digest and get rid of the previous feeding, since it takes about 3 hours for the average baby's stomach to empty itself. In many cases lengthening the interval between feedings to 3 or 4 hours will promptly stop the trouble.

3. *Nursing Too Fast at a Free-running Breast.*—A vigorous baby will sometimes nurse so fast, especially if the mother's milk flows rapidly, that he will promptly get a big hard milk curd in his stomach and have a pain as big as his appetite. To avoid this the mother may pull the nipple from his mouth for a few moments several times during the nursing. He had better cry from indignation over this than from real pain later.

4. *Swallowing Air.*—Breast-fed infants who have no obstruction in breathing are not so apt to swallow air as are artificially fed infants. However, some do, and the stomach may be so distended with a bolus of air that there is actually not room for a sufficient amount of milk. The mother should lay the child against her shoulder and pat his back until the air escapes. When he belches up the air, a small amount of milk may come with it. Pediatricians now advise patting at the end of nursing, and one or more times during nursing if the baby is inclined to swallow air (see Fig. 57).

5. *Insufficient Food.*—Some pediatricians assert that, contrary to popular belief, this is a frequent cause of colic, particularly evening colic. Evening colic may be one of the first signs of a

dwindling milk supply. The gastric glands secrete acid at the usual time, and if there is not milk enough to combine with it the contents of the stomach become highly irritative, and increased peristalsis may even cause vomiting. Usually, however, the baby simply shrieks until the stomach empties the irritating substance into the bowel. This type of colic is apt to come on in the afternoon or evening because it is the time when the mother is tired and her milk secretion the lowest. The baby acts hungry, drinks water greedily, and sometimes pulls away from the empty



FIG. 57.—Patting the back to expel air.

breast with a cry of rage. Weighing the baby before and after nursing as mentioned on page 280 will determine how many ounces of milk he has actually obtained. A supplemental feeding of modified milk after the breast is drained will often put an end to the classic "three-month colic."

Colic accompanied by under weight, constipation, diarrhea, or other signs of poor nutrition or poor condition should be promptly referred to a baby specialist. Here, as always, lay advice is dangerous.

6. *Rickets.*—Low-calcium rickets may cause convulsive indigestion resembling colic. This will occur in infants receiving insufficient vitamin D, calcium, or phosphorus. The infant may have been predisposed on account of his mother's prenatal diet and race, or her diet during lactation. He will require cod-liver oil,

sunshine, and the essential minerals in addition to his mother's milk.

7. *Acute Infections.*—Infants may have acute indigestion in connection with sinus or ear infections. Because the infant cannot describe or locate his distress, the real cause in this case may be overlooked and neglected.

Weaning. *When to Wean.*—Under normal conditions weaning should be a gradual process, beginning at seven to nine months and ending by eleven or twelve months.

Not all mothers can adequately nurse a baby so long, and it will be necessary to begin supplemental feeding at any time the breast milk becomes insufficient in quantity or quality.

All authorities agree that the baby should have all the milk his mother can give him and have it regularly, and that the breast milk should not be permitted to dry up until he is safely established upon his post-weaning dietary. The supplemental feeding should be given just after he has taken all the milk there is in the breast. Then he may have enough of the artificial food fully to satisfy his hunger. Even a little bit of breast milk seems to aid in the digestion of other food.

Some pediatricians advise one bottle-feeding daily almost from the start. Their reasons are: (1) The baby is trained for weaning or any emergency in which it may be necessary to place him entirely on the bottle; and (2) it gives the mother a period of freedom during which she may get away from home for business or pleasure.

Breast-milk Stations.—So great is the value placed by pediatricians upon human milk for the human baby that milk is now purchased and dispensed by many city feeding clinics. Fortunately many women produce more milk than their own infants can consume. The surplus may save the life of another infant who is deprived of his right in this respect. Women selling their breast milk must pass rigid health examinations, and the milk is withdrawn under strictly aseptic conditions. Naturally a high price must be paid to induce women to take this trouble. During 1927 a total of 17,466 ounces of breast milk was collected and dispensed by the feeding dispensary of Boston.[1]

[1] Talbot, Fritz, An Organization for Supplying Human Milk, *New England Journal of Medicine*, Sept. 27, 1928.

In former times, before the invention of rubber nipples and modified milk, or the rise of sanitary science, the only salvation for an infant who was deprived of his mother's milk was the wet-nurse, meaning the mother of another babe who, because of pay or pity, shared her own infant's food with the unfortunate one, and nursed two babies at once. Wet-nurses are still employed where breast feeding is vitally important to an infant and human milk cannot be purchased. Great care must be taken as to the health and habits of a woman who nurses a delicate infant not her own.

If the mother becomes pregnant, weaning as a rule must be begun at once and pushed rather rapidly. Few women can properly nourish two successive children at once. Occasionally a vigorous woman can do this by strictly observing the most advantageous diet and care.[1] The physician should always determine the feasibility of this.

If the mother becomes ill the doctor must decide if weaning is advisable. Fortunately, it is seldom necessary in ordinary illnesses.

The return of menstruation does not usually injure the milk supply. A nursing mother who menstruates should, however, be especially careful not to overwork or become too tired, especially at her periods. Occasionally the flavor or quality of the milk seems to be altered at the time of the periods, but this is rarely, if ever, injurious to the child.

How to Wean.—When it is determined to begin to wean the baby, it is usual to begin by giving cow's milk modified by the formula for one or two months younger than the actual age of the child (see chap. XVIII) in the place of the second or third daily nursing.

If the child is sitting alone this should be given from a small cup. It is well worth while to teach the child to drink the milk rather than take it from a bottle, as it is very much better than continually to have to sterilize nipples and bottles; it is better for the teeth, and it also does away with the very troublesome process of "breaking from the bottle" later. This is often much more difficult than weaning from the breast. If the milk agrees with the baby after a few days' use, the strength should be rapidly increased to the formula for the actual age.

[1] Van Blarcom, Carolyn, *Obstetrical Nursing*, p. 265, 2d ed., The Macmillan Company, 1929.

When the baby is one month older modified cow's milk may be substituted for another feeding. In another month a third nursing may be replaced, ordinarily now using whole milk. At the end of the fourth month the fourth and last nursing is replaced. Most mothers prefer to keep the evening nursing until the last.

If weaning is properly conducted the milk flow will gradually lessen, the baby will gradually become accustomed to other food, and the only one to experience any grief will be the mother, who will regret that the supreme experience of nursing her baby is to be no longer hers.

If the baby should be nine months old in July or August (in a climate in which these are hot months), he should be given fruit juice, cereal gruel, vegetables, and modified cow's milk, etc., *in addition to his mother's milk*, but it will be safer to withdraw the mother's milk more slowly and keep the milk flow until cool weather, for it is very valuable to the child if illness should occur during hot weather.

When to Give Food Other Than Milk before the End of the First Year.—There is a tendency among pediatricians to give foods other than milk earlier than formerly, and in greater variety. Such foods must be carefully selected and correctly prepared, and this new attitude does not justify feeding the baby "tastes" of everything or *anything* from the adult table.

The infant's diet is now selected for the purpose of securing the food factors which newer nutritional science has shown to be important. They are the same in order of their importance to the child as to the mother: (1) Proper growth proteins, (2) minerals, (3) vitamins, (4) carbohydrates and fats for energy calories. These essentials have been discussed as to importance, effect, and source in Chap. X. The application to the child will here be made.

Growth Proteins.—The best source of these is human milk; next best is cow's or goat's milk. At any time that the mother fails to supply enough protein to her growing babe arrest in growth will occur and breast milk must be supplemented by other milk. Milk is commonly the one important source of protein for the nursing infant and young child.

Minerals.—The calcium and phosphorus requirements of the nursing infant are well covered by an adequate milk ration. There is a negligible amount of *iron* in either human or other milk. The infant is born with a sufficient storage of iron in his liver (if his mother's diet has provided this surplus) to meet his needs up to approximately six months. Iron must be provided from sources other than milk from the time his own reserve begins to fail; otherwise his blood and tissue chemistry will suffer, and he will become in some degree anemic. The two best of the known sources of iron in digestible, practicable form are leafy vegetables and egg yolk. It is now customary to add water in which leafy vegetables have been cooked to the drinking water of the infant from two or three months on and sometimes almost from birth, since there is such a factor of uncertainty as to the iron storage of the infant, and the mineral content of the mother's milk. Vegetable mash (described on page 341) may be given from six months or before, beginning with a small amount and increasing gradually. Egg yolk, either raw or cooked, may be given every day or every other day from five to six months or even younger, beginning with a small teaspoonful. Potassium and sodium will be supplied by the vegetables and cereals recommended. Chlorine is provided by table salt, which is important in the mineral metabolism of the child but should not be used to excess.

Iodine, copper, sulphur, magnesium, etc., will be abundantly provided in the foods supplying the other named essentials.

Vitamins. *Vitamin A, the growth and immunity vitamin,* will be abundantly provided in an adequate whole-milk ration, plus the vegetable pulp, especially yellow vegetables and leafy vegetables, and the egg yolk as recommended for iron in the preceding paragraphs.

Vitamin B, the *appetite vitamin,* is also indispensable to growth. Milk is only fairly rich in B. Whole cereals are an important source. The addition of whole-grain cereal gruel well strained is advised, beginning usually at from the fifth to the seventh month. As with all new food, only a small amount should be given at first, increasing gradually. Any edible grain may be used as directed on page 340.

Vitamin C, the *dental vitamin,* is found in orange and other citrus fruit juices, tomatoes, and green leaves. Vitamin C is

found in fresh milk in proportion to its presence in the food of the animal or human producing it. Because it is a variable quantity in breast or other milk it has become the practice to give citrus juice or tomato juice very early, beginning in the breast-fed baby at two or three months and in the artificially fed child almost from birth, since most artificial food preparations are heated and heat is destructive to vitamin C.

Juices from *carefully selected* ripe, sweet oranges or tomatoes, or from a high-class brand of canned tomatoes, should be given in teaspoonful amounts at first, well diluted with water. By six months the portion may be increased to one tablespoonful or more twice daily.

Vitamin D, the *antirachitic vitamin*, is known to be formed within and by the animal body through the stimulation of the ultra-violet rays in direct sunlight. It is also formed in plants in the same way. Fresh milk from cows who eat irradiated foods or who run in sunny pastures is moderately rich in D. It is such an unreliable source, however, that it is necessary to reinforce it, in the temperature zone, with antirachitic foods such as cod-liver oil or Viosterol or Halivor oil, and egg yolk, and make doubly sure by exposing infants regularly to the direct rays of the sun, or a carbon arc light or mercury vapor quartz lamp.

If the essentials named are provided there is no possibility of shortage of vitamins E and G.

With the above facts in mind we may construct a chronological dietary schedule up to the first birthday somewhat as follows, always remembering that any schedule must be adapted to the particular child, with the use of common sense, and according to good medical supervision.

1. From the age of three to four weeks vegetable water may be added in slowly increasing amount to the drinking water or given separately.

2. From two to three months give orange juice or tomato juice, gradually increasing the amount.

3. From one to three months if the baby is born in later summer or fall, at two to three months if born in spring, give cod-liver oil, beginning with one-half teaspoon daily as directed by the physician, increasing to three times daily. It may be added to orange or tomato juices. Viosterol or Halivor oil (see page 309)

is prescribed by physicians in some cases as a substitute for cod-liver oil, but should not be used unless so prescribed.

4. At four to six months cereal gruel may be given once daily, and gradually increased.

5. At five to seven months give vegetable mash or pulp one or more times daily.

6. With appearance of the first teeth give crust of dry bread, or zwieback, or hard cracker, to encourage chewing, spacing of teeth, and development of salivary glands. By one year these may be given twice daily before regular feedings.

7. At six to eight months, sometimes much earlier, give a small amount of egg yolk daily, increasing until by one year the child may have a whole egg several times a week.

8. For variety, baked apple, prune juice and pulp (if not too laxative), ripe pear, baked potato, etc., may be given in small amounts occasionally from nine months on. Also milk soups, junket, custard, scraped steamed liver, crisp bacon, etc., may be given in small amounts for variety.

A very good feeding schedule for nursing babies is found in *Foundations of Nutrition* by Mary Swartz Rose. Excellent daily schedules for each month including sleep and activity are also issued by the Children's Bureau of the U. S. Department of Labor.

By the end of the first year the following amounts are reasonable to expect a child to eat [daily]: one quart of whole milk either to be drunk or taken combined in soup; 1½ slices whole wheat bread or the same toasted; 5 tablespoons of orange or tomato juice; ½ teaspoon of cod-liver oil; 3 to 5 tablespoons of cooked fruits, such as prunes and apricots; 5 tablespoons of finely minced green vegetables, such as peas, spinach, string beans, carrots; 3 to 5 tablespoons of mashed potato, and 3 to 5 tablespoons of cereal, preferably whole-grain cereal; half to one yolk of an egg; 1 to 3 teaspoons liver sieved, or the same amount of scraped beef. Cream soups can be used also to vary the menu.[1]

Eating Habits. *Regularity.*—Every child, no matter what his age, should eat regularly. In order to be ready to eat at the regular time the baby must sleep at a regular time. Nothing should interfere with the baby's regular schedule. No matter how busy a mother may be, it takes more time to care for a cross,

[1] RAND, SWEENY, and VINCENT, *Growth and Development of the Young Child*, p. 253, W. B. Saunders Company, 1930.

"fussy" baby than to be punctual and systematic and always have a healthy, happy child.

Eating Alone.—From the very beginning of giving solid food, the baby should sit on his own chair before a little table. He will learn to eat properly and will see only his own food, and so will not even be curious about what the rest of the family eat. The mother can then eat her own meal in peace and quiet while the baby plays happily in his play pen or sleeps. The rest of the family will not be tempted to spoil his liking for simple, wholesome food by giving him "tastes" of things he should not have. This plan eliminates the dangerous high chair, which need never be used.



FIG. 58.—The child should learn to feed himself at his own little table.

Chewing.—The baby should be encouraged to chew and should be given plenty of time to sip his milk and chew every bite of food, but he should be kept continuously busy until he has finished his meal. *It is all-important that the habit of deliberate, careful chewing be encouraged from the start.* When the baby's teeth come through the gums he wants to chew. This is the psychological moment. Let him never forget for one day how to chew. If this instinct once fades and bolting the food becomes a habit, it is very hard ever to train a child to chew his food properly. It is a great mistake for a busy mother to feed a child entirely on soft food from a spoon because it can be done more quickly and easily than to bother with letting him feed himself. This is training him in bad habits and is injurious to his manners, digestion, teeth, and health.

Eating between Meals.—In no one thing will the mother have harder work than she will in preventing well-meaning but mistaken relatives from giving the baby cookies, candy, pop, ice

cream, etc., between meals or when visiting. No growing child should ever eat sweets of any kind between meals. *Especially should no child during its "second summer" ever have a taste of anything not included in its regular feeding schedule.* If the child seems hungry between his regular meal periods his food requirements may be increasing with growth and he may need more or heartier food. He may not be eating enough breakfast. If he seems to require an extra meal or lunch this should be established as a regular function. Otherwise the rhythm of his metabolism and elimination will be disturbed.

The establishment of regular physiological rhythms through the establishment of regular health habits is fundamental not only to health but to mental training and development, a subject which is more fully discussed in chap. XXVII.

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CHAPTER XVII

RICKETS

The exact food, the careful shelter,
The fresh air, sunshine and wide spaces
Of sky and meadow
For frolic play and happiness,
Given without stint to the young lambs
And the young colts and the young cattle—
Let us give Everychild these!

FREDERICK PETERSON.[1]

Rickets is said to be the most prevalent disease of early childhood occurring in the temperate zone. Dr. Alfred F. Hess says: "It may be conservatively stated that one-half of infants [in the temperate zone] suffer from this disorder in greater or less degree during the first two years of life."[2] It occurs in inverse ratio to the incidence of sunlight unobstructed by clouds, smoke, or dust. Naturally it is more prevalent in large cities than in the open country, and most prevalent among the children in crowded or congested districts. In certain city areas practically all children are affected in some degree by rickets.[3]

Rickets is described as a disease of childhood in the earliest medical literature.[4] Because of the obviousness of the changes and distortions of the bones it was long considered to be a specific disease of bone tissue. With the better knowledge of mineral metabolism and biological chemistry and improved diagnostic

[1] "Every Child," *North American Review*, November, 1922.

[2] Conference on Child Health Protection, Medical Section, Committee on Nutrition, *U. S. Daily Supplement*, p. 88, Apr. 6, 1931.

[3] BUNDESER, LEMON, FALK and COADE, Ultra-violet Radiations from Sunlight and Incandescent Lamps, *Journal of the American Medical Association*, July 16, 1927.

[4] MCCOLLUM, E. V., *Newer Knowledge of Nutrition*, 3d ed., The Macmillan Company, 1925; also ALFRED F. HESS, *Rickets, Osteomalacia, and Tetany*, chaps. on History and Distribution, Lea & Febiger, 1929; JOHN H. FOOTE, Evidence of Rickets Prior to 1650, *American Journal of the Diseases of Children*, September, 1927.

methods it has become clear that certain important phases of the delicately balanced organic chemical "pattern" of the young child's body are definitely disturbed, *and that these changes involve metabolic balance and function of the entire system.*

J. H. Hess says, "Rickets is a chronic general disorder of nutrition. . . . The pathological changes, while most evident in the osseous [bony] structure, may involve all of the body tissues and organs, including the nervous, muscular, respiratory, and circulatory systems, the blood-making organs, liver, skin, hair, teeth, and nails."[1]

The very precise relationship and fixed proportion of the various minerals incorporated within the chemical pattern of the body have been discussed in chaps. I and X. It will be remembered that there is a delicately adjusted balance between calcium, phosphorus, and magnesium (page 179); also that the maintenance of this balance seems to depend upon the activation of the provitamin ergosterol in plant and animal tissues by the ultraviolet ray, and that all this is closely related to and dependent upon the normal functioning of the parathyroid and pituitary glands and possibly other endocrines.

While the calcium-phosphorus balance in rachitic bone remains unchanged with reference to the relation of these two minerals to each other, the total calcium-phosphorus content is diminished in rickets, while the magnesium content seems to be increased.[2] Since the newer research (see page 185) shows that, in the absence of magnesium, calcium and phosphorus are drained out of the tissues, it would seem that the magnesium increase in rickets may be compensatory like the enlarged thyroid in shortage of food iodine.

While the calcium content of the soft tissues is small it is important, as is shown by the development of tetany (a disease characterized by extreme nervous irritability, even convulsions) following even a small decrease in the blood calcium. The bony skeleton contains 97 to 98 per cent of the total body calcium; phosphorus, on the other hand, is found in the soft tissues to the extent of 25 to 30 per cent of the total for the body.[3]

[1] Hess, J. H., *Feeding and Nutritional Disorders in Infancy and Childhood*, p. 349, F. A. Davis Company, 1927.

[2] Hess, *op. cit.*, pp. 146–147.

[3] *Ibid.*, pp. 148–150.

The whole chemistry of the rachitic complex is complicated and involved and awaits the results of further research for its entire clarification. It is clear that the presence of vitamin D is essential to the incorporation of these minerals within the colloidal protoplasms of the body. It is clear that deficiency of vitamin D produces rickets, and it is clear that certain lines of treatment are both preventive and curative.

The symptoms of rickets are many, and not all of them will appear in one child. Often only two or three will be seen. The extreme distortions and permanent deformities of bone of earlier times are now rarely seen. Dr. Alfred Hess says the modern cases are as a rule mild, healing without specific treatment and leaving no deleterious effect, so far as we know, except that they may bring about deformities of the pelvic bones leading to serious difficulties in childbirth.[1]

Head sweating is one of the earliest symptoms and may appear as early as the sixth week of life. The baby's head sweats when he nurses or cries and in severe cases when he sleeps. He is apt to roll and toss the head or grab at it, possibly because of the discomfort of the sweating.

Bone Changes.—The *rachitic rosary* is the name given to enlargements of the cartilages where the bone and cartilage of the ribs unite on either side of the sternum or breast bone. *Harrison's groove* is a curving of the ribs where the diaphragm pulls on the abnormally soft bones, forming a characteristic curve or shelf which is intensified by the posture of the child when he is first placed in a sitting position. Since the bowels are apt to be distended with gas and the bones are abnormally flexible, this deformity readily occurs. *Pigeon breast, barrel chest,* and other distortions of the chest walls often remain as permanent deformities. *Bosses* or enlargements of the skull occur, giving the characteristic large, square head of early rickets. *Enlargement of the joints* at the epiphyses (growth line), *bowed legs, knock knees,* and *flat feet* may be caused by rickets. *Distorted or deformed pelvis* may, as just stated, complicate child-bearing in later years. Gebhart says,

"We also found that while deformities of the extremities such as bowed legs or knock knees, tend to disappear, those of the thorax and

[1] *U. S. Daily Supplement,* Apr. 6, 1931.

pelvis are retained for many years, if indeed they are ever fully outgrown. The flattened and narrow rachitic pelvis of girls, if not 'outgrown' causes complications and may involve considerable risk of life for both mother and baby during childbirth."[1]

Delayed and Imperfect Teeth.—The teeth of the rachitic child are apt to come in slowly and be of poor quality of dentine and enamel.

Delayed Closing of Anterior Fontanelle.—The "soft spot" on the top of the child's head should close by eighteen months. In rachitic children this may not occur until twenty-four or thirty months.

Poor Muscular Development. Rachitic children tend to have flabby muscles, "winged" scapulae, protuberant or "pot-bellied" abdomens, pronounced lumbar curve, and loose joints. They sit, stand, and walk later than normal children.

Digestive Disturbances.—Certain types of colic, poor assimilation of food, and constipation accompany and are probably caused by the rachitic condition, at least secondarily to the poor muscle tone of the digestive organs.

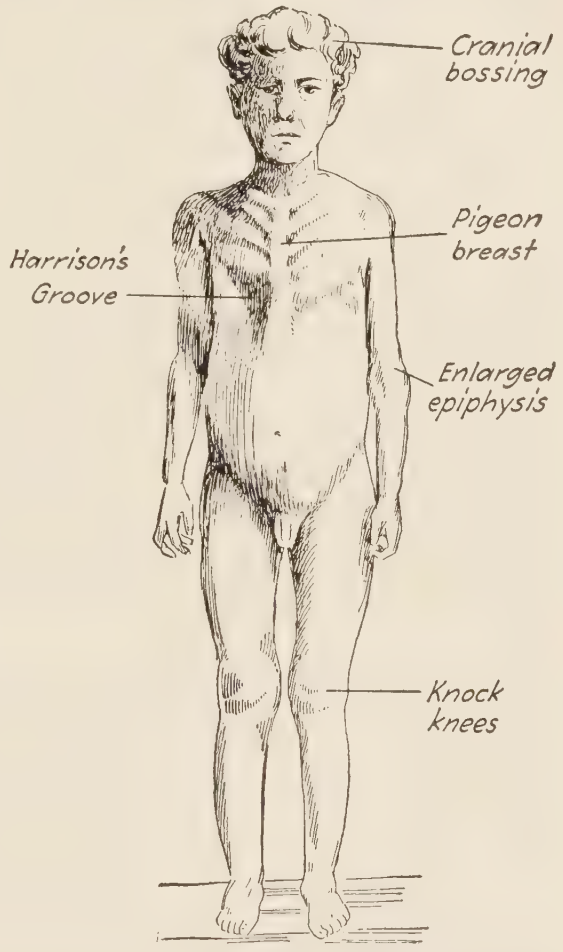


FIG. 59.—A rachitic child showing typical deformities.

Anemia.—It is said that all rachitic children have some degree of secondary anemia, sometimes accompanied by enlargement of the spleen.

Lessened Immunity to Respiratory Diseases.—One of the most serious effects or accompaniments of rickets is the lowered resistance to respiratory infections. Rachitic children are subject to colds, bronchitis, and pneumonia, and these predispose to

[1] ROSE, MARY SWARTZ, quoted in *Foundations of Nutrition*, p. 221, The Macmillan Company, 1927.

tuberculosis. It is beginning to be noticed that infants who are on the present approved antirachitic regime rarely develop bronchopneumonia and are very resistant to colds.

Susceptibility to Convulsions.—Lack of calcium in the blood and tissues makes the nervous system highly irritable, and rachitic children easily go into spasms or convulsions. This is closely allied to tetany, a disease which produces extreme nervousness.

Age of Onset.—There has been a good deal of discussion as to whether an infant ever develops rickets before birth. It seems to be generally believed that the child is rarely if ever born with active rickets. Dr. Alfred Hess says that the overt condition tends to begin about the third month and end about the eighteenth month. He also says:

> We have reason to believe that the newly born infant brings with it into the world but little of the protective, antirachitic factor, and that the disturbance in metabolism designated as rickets probably starts during the first weeks of life, its intensity and progress varying in the individual according to the interaction of a large number of determining factors.[1]

He thinks it is possible that, owing to nutritional errors during pregnancy, the infant might be born with rickets or a tendency to develop this disorder, although the effects of nutritional deprivation are well known to be visited upon the mother rather than upon the fetus. Premature infants and twins are said to be especially liable to develop rickets.

Prevention and Treatment.—*Vitamin D, the "antirachitic factor,"* is the specific for both prevention and cure of rickets. It is now known to be created, as has been said, through the stimulation by ultra-violet rays of ergosterol, which is found extensively in plant and animal tissues. The ergosterol is most directly exposed to the rays of the sun in the leaves of the plant and in the skin of the animal, and it is here that vitamin D is supposed to be most extensively manufactured. Vitamin D is stored in certain organs and tissues, notably the liver. Salt-water fish, especially halibut, salmon, and cod, because of the rich source of vitamin D in certain marine plants which they eat, have the highest known natural concentration of vitamin D in their livers.

[1] Hess, *op. cit.*, pp. 91 and 409–413.

Vitamin D is obtained for medicinal use in solution in the well-known oil of the cod's liver. Salmon and other marine fish have high vitamin D concentration[1] and halibut liver oil is now marketed as "Halivor oil."

Irradiation.—It has been known for some time that ultraviolet rays could be produced from other sources than the sun, especially from the mercury vapor quartz lamp and the carbon arc lamp. Carefully regulated exposure of rachitic children or animals to these lamps cures and prevents rachitic symptoms through stimulating the provitamin ergosterol in the skin to manufacture vitamin D.

Viosterol.—In 1926 Steenbock of Wisconsin, Hess of New York, and several other investigators discovered almost simultaneously that certain susceptible food substances could be "activated" by irradiation with these lamps and would exhibit an increased amount of vitamin D, and that these foods would then prevent and cure rickets. Since general irradiation of food would be a clumsy and expensive process, Professor Steenbock developed a method of irradiating ergosterol concentrate, obtained from yeast or ergot, in such strength that a minute quantity is highly protective. This product has been standardized and patented as a means of control and of prevention of commercial exploitation. The name Viosterol was given to this officially by the Council on Pharmacy and Chemistry of the American Medical Association. This means that all preparations of Viosterol on the market have a uniform content and are made by the same formula.

Viosterol is a highly potent form of vitamin D. It contains none of the growth vitamin A, however, as artificial irradiation destroys vitamin A, and it is no more effective as an antirachitic than is cod-liver oil. Since cod-liver oil is also an important source of vitamin A it really has a higher value to the young child than Viosterol. Viosterol, however, being practically tasteless and odorless, and being administered in very small doses, has a value in cases in which administration of cod-liver oil is difficult.[2] When it is used, however, more milk fat and green

[1] Nelson and Manning, Salmon Oil a Source of Vitamin D, *Science News Letter,* Apr. 19, 1930.

[2] Hess, Lewis, and Rilkin, New Aspects of the Therapeutics of Viosterol, *Journal of the American Medical Association,* June 14, 1930.

vegetables should be used in the diet of the child to make up for the lack of vitamin A in the Viosterol.[1]

Cod-liver oil seems to be most effective when given in a clear or natural state. Fortunately, infants do not object to the taste. Children who take it continuously during infancy are not apt to develop a dislike for it, but it is difficult to get a child to go back to it after he has once stopped. There are various flavored preparations available which may be used if necessary.

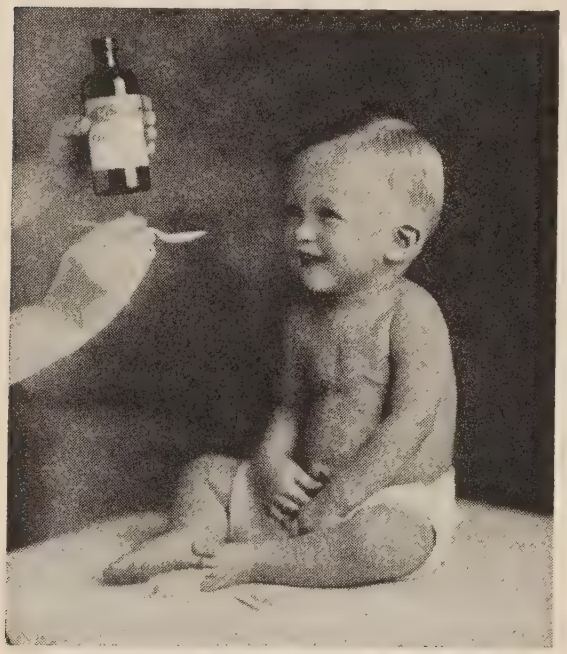


Fig. 60.—I like my cod-liver oil.

Some pediatricians begin giving cod-liver oil at one month; one-fourth to one-third of a teaspoonful twice daily at first, increasing to one teaspoonful twice daily at four months and three times daily at six months. While a child is getting out of doors freely in the summer time he may not need this protection if the air is free from smoke and dust. It is often difficult to begin its use again in the fall, however; therefore it is simpler to give a small dose twice daily even through the summer. It is usual to give the cod-liver oil in the orange or tomato juice, thus combining the antiscorbutic with the antirachitic prophylaxis. The use of cod-liver oil should be continued through the baby's second winter. If he lives where he does not have plenty of sunlight it should be continued throughout his preschool years.

All of the antirachitic protectives should be given under direction of a physician and the dosage regulated to the individual child, otherwise hypermineralization may occur, even leading to the deposit of calcium salts in the kidneys and other tissues.[2]

Egg Yolk.—The other important sources of vitamin D are egg yolk and liver. The vitamin D content in egg yolk varies with

[1] Viosterol contains D but not A, *Journal of the American Medical Association*, Jan. 4, 1930.

[2] *Science*, May 26, 1933, p. 13.

the diet and care of the hen, being higher when she is freely exposed to sun or lamp rays and where she herself receives antirachitic food.

Both J. H. Hess of Chicago and A. F. Hess of New York[1] give egg yolk to very young infants, sometimes even using it instead of cod-liver oil, beginning with one-fourth to one-half of a yolk shaken up with one bottle feeding per day at one to two months and increasing to one entire yolk by four months. Dr. Rupe gives as much as one to two egg yolks daily at four months to rachitic children.[2]

Butter Fat and Green Leaves Are Not Highly Protective.—Since vitamin D is associated with vitamin A, which is abundant in milk fat and in green leaves, it was thought for a long time that these were important sources of vitamin D. Vitamin D has been separated from vitamin A and later research disproves the view that these substances are important sources of vitamin D. Butter fat from animals receiving antirachitic treatment does contain vitamin D, and this is no doubt important in the general diet, but the concentration is not sufficient to be protective or curative in the case of a child who is not manufacturing his own vitamin D under the stimulus of abundant sunlight or other source of ultra-violet ray. Green leaves, even when grown in the open, are now said to have little antirachitic property. Leafy vegetables when irradiated with ultra-violet lamp, which is much more powerful than the sun's rays, do become activated. While green leaves are indispensable in the diet of the young child for many reasons, their use will not protect the child from developing rickets.[3]

Sun baths are advised for pregnant women and infants as a prophylactic measure. They may be given to the infant from two weeks of age on, under favorable circumstances. Outdoor weather conditions in the north temperate zone are so difficult and variable and the rays of the sun are so often filtered through screens of smoke, fog, or dust, and there are so many cloudy or rainy days that it is impossible to give any child sufficient regular exposure to the sun's rays to safeguard him.

[1] Hess, J. H., *Feeding and Nutritional Disorders in Infancy and Childhood*, F. A. Davis Company, 1927.

[2] Rupe, Wayne, *Lectures in Pediatrics*, University of Kansas, 1928.

[3] Hess, A. F., *op. cit.*, pp. 73–76.

If the child is born in the spring or summer, sun baths may be begun as soon as the mother is about and fully able to attend to



FIG. 61.—No rickets here!

them. Great care must be taken to accustom the child to them gradually.

Dr. Rupe directs that the infant be stripped, except for the diaper, and exposed 2 minutes front and 2 minutes back daily,

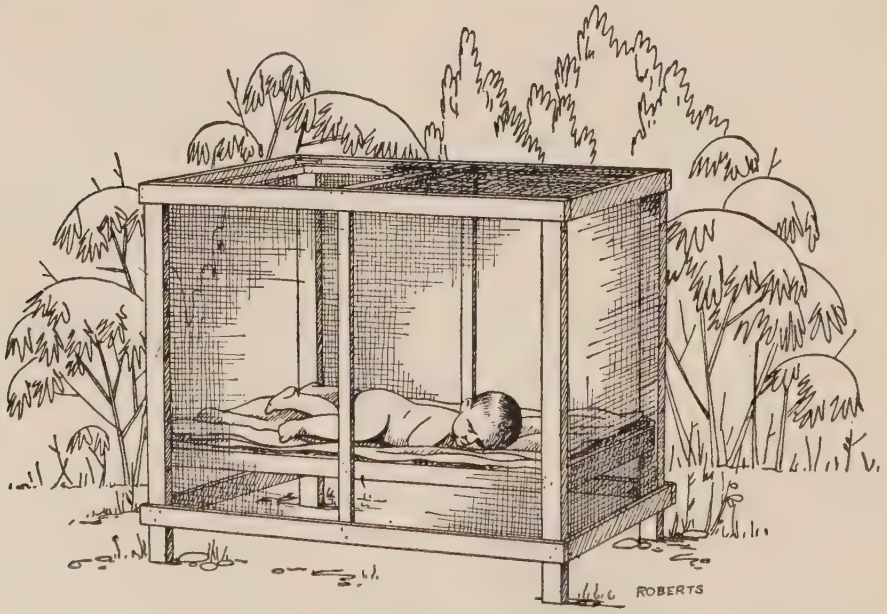


FIG. 62.—A homemade screened cage for the sun bath and outdoor nap.

lengthening the exposure gradually to 5 minutes back and 5 minutes front within two weeks. When he sits alone let him sit stripped for 15 to 20 minutes in his carriage. Runabout children

should wear the smallest possible excuse for a sun-suit and become tanned all over.[1] No child should be exposed long enough to redden the skin. This is an important caution in the case of certain infants who burn but do not readily tan. J. H. Hess begins with exposure of the feet for a few minutes, gradually increasing surface rather than lengthening the time. Even in the winter an infant may be exposed before an open south window in the focal point of the sun's rays and well protected from draught for a few minutes on bright days.[2]

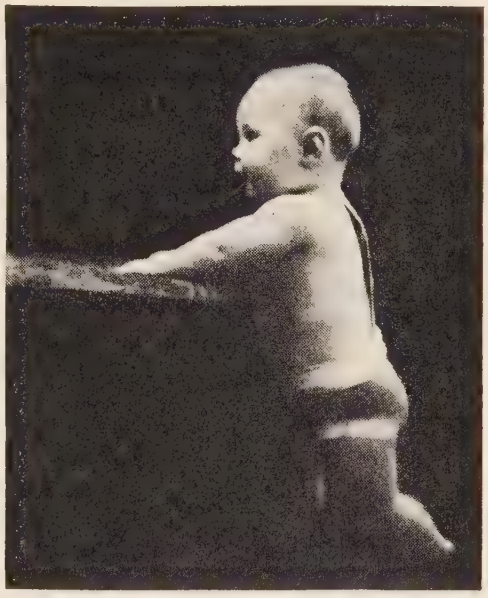


FIG. 63.—The smallest possible excuse for a sun-suit.

Window Glass.—The ultra-violet rays penetrate loose-meshed clothing to a certain extent, but do not pass through ordinary window glass. There are special kinds of more or less transparent substances which do permit the passage of the rays, such as vita glass, cellophane, and a number of others. Children's hospitals, institutions, and nursery schools now often have one pane or one window of such glass on the sunniest side of the building. At best these substances transmit appreciably less than the total rays and gradually become "old" and ineffective.[3]

Caution.—Treatment with artificially produced ultra-violet light is also a dangerous thing unless carefully administered and controlled. Cases are being reported of serious "hypermineralization" in which the mineral balance of the body is disturbed. A word of caution is necessary because of the exploitation of the public through the advertising of all sorts of ultra-violet lamps. It is natural to think that it might be a good thing to purchase these and use them without medical direction. *It cannot be too*

[1] RUPE, WAYNE, *University Extension Lectures*, University of Kansas, 1928.

[2] *Sunlight for Babies*, U. S. Department of Labor, Children's Bureau, Folder No. 5, 1921; also, *Infant Care*, Children's Bureau, Washington, D. C.

[3] NICHOLSON, PERCIVAL, Status and Technique of Natural and Artificial Heliotherapy, *Archives of Pediatrics*, July, 1929; also Rickets, a Symposium, *American Journal of the Diseases of Children*, November, 1927.

strongly stressed that irradiation is a new and powerful instrument potent for both good and harm.

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CHAPTER XVIII

ARTIFICIAL FEEDING

Milk Song

Father, it is Thy kindness
Gives us milk to drink,
Milk, how pleasant tastes it,
Very good we think.
In the cup or basin,
It is white as snow;
Sweet as the flowers
(That) In the fields grow.
Milk the red cheek freshens,
Makes the mind serene.
Beautifies the sunshine
Brightens all the green.
Yes, it is Thy kindness
Ever great and good,
Gives the milky treasure,
Children's sweetest food.
Father, may we never
Be denied this food;
Nor seek after other.
While this is so good.

LOWELL MASON.[1]

Artificial Feeding a Problem.—Whenever it becomes necessary to feed a baby something in place of its mother's milk the child becomes a problem. What will agree with one may not agree with another. A food may not cause acute indigestion or actual illness and yet the baby may not make good bone, muscle, and blood out of it. A baby may not appear to be sick and still may not make a normal gain in weight. He may be unable to digest the fat in cow's milk, or the protein (curd) may disagree, or the sugar used in modifying the milk may cause diarrhea and distress. It takes medical skill and experience to make the proper diagnosis. A baby may lay on soft fat and be oversized, and still not have good muscle or be strong. *Every bottle-fed baby should be fed under the directions of a physician, who should see him often.* It is much safer to prevent trouble than to cure it.

It is desirable for a mother to be sufficiently informed on the subject of artificial feeding to cooperate with the pediatrician in an understanding way. She will never under any circumstances take the responsibility of directing the artificial feeding of her infant. The leading foods and methods are here presented

[1] From an old book of *Little Songs for Little Singers*, 1840, quoted by Crumbine and Tobey in *The Most Nearly Perfect Food*, Williams & Wilkins Co., 1929.

in brief form for the use of the student or mother if the information is needed or desired.

Fresh-milk Feeding.—Cow's milk and goat's milk are usually the best substitutes for mother's milk. *There is no perfect substitute for mother's milk.* The best imitation which anyone at present knows how to make is made from cow's or goat's milk. Usually fresh cow's milk is the most accessible and the cheapest food, and it is usually satisfactory for the infant who cannot have his mother's milk. Milk which is given to any child should come from sources well known to the mother. Grade A certified milk should be used if it can be obtained. The pediatrician is usually informed as to the local supply and will recommend a satisfactory source. The cows must be tuberculin tested, fed on vitamin-rich food, and housed and milked under sanitary conditions.

Milk from Holstein or Ayrshire cows is more like human milk than that from Jerseys or Herefords. Jersey or Hereford milk is too concentrated in fats but may be used with the removal of part of the cream. Milk from a healthy herd tends to be more uniform and is ordinarily better than milk from one cow unless it is important to feed soft-curd milk.

Soft-curd milk is offered by some dairies which specialize in milk for infants. One of the reasons cow's milk sometimes disagrees with infants and others having delicate digestive systems is that the cow's curd (protein) is made up of a larger percentage of casein and a smaller percentage of lactalbumin than human milk and makes a hard curd when it is "curdled" by the acid gastric juice. Occasionally a cow is found in all breeds which has a high percentage of lactalbumin and gives milk with a "soft curd." Holstein-Friesian and Ayrshire cows more frequently give soft-curd than other breeds. There are practical curd tests which can be applied in any dairy, and it is probably advisable to use soft-curd milk in all cow's-milk feeding.[1]

Milk is the most valuable and indispensable of human foods. It is the one best growth-producing food for children. It must be remembered, however, that *not only children, but other living things thrive and grow on milk, among which are germs, both*

[1] *Milk for the Family*, U. S. Department of Agriculture, *Bulletin* 1705, July, 1933.

good and bad. Disease germs multiply by millions in warm milk. A few from the foot of a fly, the udder of the cow, a dirty milk pail, or from contaminated water with which the milk utensils may have been washed, will multiply to millions within a few hours if the milk is not kept cold. *Cleanliness and cold are the watchwords for safe milk.* Milk should be cooled quickly after milking and be kept below 50° until prepared for the baby's use.[1]

Preparations of Cow's Milk.—*Sweetened condensed milk* is preserved by heating, partial evaporation, and addition of sugar (18 to 20 pounds per 100 pounds of milk) as a preservative and to prevent freezing. This method is said to have been originated for the use of Napoleon's armies, and its use was introduced in this country at the time of the Civil War. It has doubtless had great value in certain food emergencies. Because of its convenience it has had a vogue in infant feeding in this country. The recent advance of nutritional science, however, clearly shows the use of sweetened condensed milk as an infant food to be a faulty procedure which is now almost universally condemned by pediatricians.

Some infants who have a high sugar tolerance apparently thrive and grow fat on sweetened condensed milk. The flesh is soft ("water-logged") because sugar has an affinity for water, the osmotic balance of the body cells is disturbed, and more than a normal amount of fluid is stored in the tissues. For the same reason the bowel movements of the child so fed are loose and frequent. Infants seldom have constipation while taking this diet, but almost always suffer a reaction and sometimes have serious trouble when they are later changed to plain milk. The bowel has become habituated to and dependent upon this constant stimulation.[2] Another reason for the soft, flabby flesh is the relative deficiency of sweetened milk in protein. Unless the child is greatly overfed, he does not receive a correct protein quotient, since a large percentage of the calories in his diet will be carbohydrate (sugar) calories. Because of the relatively low vitamin and mineral content of condensed milk the bone forma-

[1] Crumbine and Tobey, *The Most Nearly Perfect Food,* Williams & Wilkins Co., 1929.

[2] Rupe, Wayne A., *Extension Lectures in Pediatrics,* University of Kansas, 1928.

tion is poor, and resistance to infections, especially respiratory infections, is notably low.

Evaporated milk (*unsweetened condensed milk*) is fresh, whole milk which is reduced by heating in a vacuum to a consistency at which the butter fat will not separate when shaken in handling, and also to a degree which insures sterility. Recent experiments indicate that this form of preserved milk is free from the objections to sweetened condensed milk just stated, and also indicate that this form of milk may have a distinct value in infant feeding. Dr. McKim Marriott says:

> Unsweetened, evaporated milk possesses a number of advantages over ordinary cow's milk for the preparations of milk formulas. . . . It has already been completely sterilized and because of the heat treatment it forms very fine curds in the stomach. The fat present has been homogenized so as to form very fine globules. It is of uniform composition, easily obtainable and is cheap.[1]

These points are confirmed by Dr. C. G. Kerley in *The Archives of Pediatrics.*[2]

Dr. Frank E. Rice says:

> In the transformation of raw cow's milk into evaporated milk, the protein and fat are given physical properties like the protein and fat of breast milk. These are the constituents causing the greatest difficulty in infant feeding. Laboratory tests, therefore, would indicate that unsweetened evaporated milk is the best form of cow's milk for preparing the feeding formula.[3]

Dr. Icy Macy in a review of infant feeding reports that in an extended series of hospital cases those infants receiving evaporated milk did better than those fed other foods, that none of them developed digestive disturbance, and that scientific tests showed no deficiencies in their growth and development.[4]

[1] Marriott, McKim, The Simplicity of Infant Feeding, *Journal of the American Dietetic Association*, June, 1928.

[2] Kerley, Charles Gilmore, Evaporated Milk in Infant Feeding, *Archives of Pediatrics*, January, 1932.

[3] Rice, Frank E., Recent Developments in the Use of Evaporated Milk in Infant Feeding, *Archives of Pediatrics*, October, 1930.

[4] Macy, Icy, New Facts on Baby Feeding, *The Parents' Magazine*, June, 1931.

Dr. James A. Tobey reports that more than a billion pounds of evaporated milk is now conserved annually in the United States; that it is cheaper than any other form of milk, fresh or concentrated, and that the biological properties are relatively unaffected by evaporation. He says vitamin C is destroyed and vitamin B is slightly reduced, but that vitamins A, D, E, and G are present in their original potency.[1] Dr. Tobey gives the following table of dilutions for feeding evaporated milk.

TABLE FOR MODIFYING CONDENSED MILK

Age	Average weight, pounds	Evaporated milk, ounces	Water, ounces	Cane sugar or pure corn syrup		Number of feedings per day	Each feeding, ounces
				Ounces by weight	Level tablespoonful		
1 week.....	7	6	15	1	2	6	3½
1 month....	8½	8	16	1½	3	6	4
2 months...	11	9	14	1½	3	5	4½
4 months...	14	11	20	2	4	5	6
6 months...	16	13	22	2	4	5	7
8 months...	18	15	20	1	2	5	7
12 months...	21	16	16	0	0	4	8

Dried Milk or Powdered Milk.—Whole milk, of good quality, when dried under modern methods in a vacuum suffers little if any alteration in composition, vitamin content (except C), or minerals. The addition of water in proper proportion is all that is necessary to produce milk which is apparently the full equivalent of fresh milk.

There is no objection to the use of dried milk in infant feeding so far as the food value is concerned. It does deteriorate on opening if not kept cold and dark and dry, and it is, as yet, relatively expensive. Dried milk of the kind specified has the same virtues as evaporated milk; it is easily digested because the heating breaks the curd into fine particles. It is sterile when opened and is considered by some pediatricians to be

[1] TOBEY, JAMES A., Infant Feeding with Evaporated Milk, *Medical Women's Journal*, June, 1931.

more reliable than and preferable to ordinary pasteurized or boiled fresh milk.

The various kinds of dried milks have many qualities to recommend them for infant feeding. Each of them—whole, skimmed, partly skimmed, and modified—is a sanitary product of fairly uniform composition. When properly prepared and used immediately, reconstituted dried milk is very low in bacterial count. Its flavor is pleasing and not very different from that of fresh milk. It is easily digested, a quality which is always an asset in infant feeding. The quantity to use in making up the formula for an infant depends upon the kind of dried milk selected, and the age of the child, and should usually be determined by a physician. For infants, it is especially important to supplement the vitamin content of the dried milk with other foods.[1]

The following table shows the percentage distribution of the constituents of the several preparations of cow's milk.[2]

THE COMPOSITION BY PERCENTAGE OF VARIOUS PREPARATIONS OF COW'S MILK

Product	Water, per cent	Protein (N × 6.37), per cent	Fat, per cent	Lactose,* etc. (by difference), per cent	Mineral matter (ash), per cent	Fuel value per pound, calories
Whole milk	87.1	3.4	3.9	4.9	0.7	310
Cream:						
Single	72.5	2.9	20.0	4.0	0.6	942
Double	54.4	2.2	40.0	3.0	0.4	1,727
Skim milk	90.5	3.5	0.2	5.0	0.8	162
Buttermilk	90.7	3.5	0.5	4.6	0.7	167
Whey	93.0	1.0	0.3	5.1	0.6	123
Evaporated milk, unsweetened	73.7	7.0	7.9	9.9	1.5	629
Condensed milk, sweetened	27.0	8.1	8.4	54.8†	1.7	1,484
Dried whole milk	3.5	25.8	26.7	38.0	6.0	2,248
Dried skim milk	3.5	35.6	1.0	52.0	7.9	1,630

* Including lactic acid and other undetermined substances.

† Mainly added sucrose. Average percentage of added sugar is about 42 per cent of the condensed milk.

Goat's milk varies slightly in composition from cow's milk, as will be seen from the following table. The fat droplets are

[1] Milk for the Family, U. S. Department of Agriculture, *Bulletin* 1705, July, 1933.

[2] *Ibid.*, p. 18.

smaller and do not rise to the top in cream as in the case of cow's milk. The curd is said to be finer in texture.

Goat's milk must be modified in a manner similar to that for cow's milk. As far as the composition is concerned, goat's milk is probably just as suitable for infant feeding as cow's milk but no more so. It is valuable in the case of infants who are sensitized to cow's milk. In some localities where satisfactory fresh milk is not available it may be possible to keep milk goats. Goats are very resistant to tuberculosis and can be pastured on a small tract of ground. Goats are susceptible to the tropical disease Malta fever, which, however, seldom occurs in other than the extreme southern states.

THE AVERAGE COMPOSITION OF HUMAN, COW'S, AND GOAT'S MILK[1]

Kind of milk	Water, per cent	Protein, per cent			Fat, per cent	Carbohydrates (milk sugar), per cent	Mineral matter per cent	Approximate fuel value per ounce, calories
		Casein	Albumin	Total				
Woman	88.3	0.4	0.7	1.1	3.3	7.0	0.3	18
Cow	87.0	2.8	0.5	3.3	4.0	5.0	0.7	20
Goat	85.7	3.5	1.0	4.5	4.7	4.4	0.8	22

[1] Adapted from Milk and Its Uses in the House, U. S. Dept. of Agriculture, *Farmer's Bulletin* 1359, and L. EMMETT HOLT and OTHERS, A Chemical Study of Woman's Milk, *American Journal of Diseases of Children*, October, 1915.

Modifying Milk.—"Modifying milk," or "humanizing" it, as the process is aptly called in New Zealand, consists in combining milk, water, and sugar in the proportions which experience has taught best suit the needs of the human baby at different ages.

Cow's milk contains about the same amount of fat as does the average human milk, but it contains less sugar and more and harder milk curd. On this account water must be added to reduce the protein. Since at the same time the fat is reduced, some top milk or cream is sometimes added. This is not always necessary because milk fat is rather apt to disagree, and the child usually thrives better on limited milk fat at first. Experience seems to indicate that it is better for the bottle-fed baby to get

part of his energy calories from the addition of cereal waters at about two months than to depend upon the milk fat for a full quotient. Then, since the human baby needs relatively more milk sugar than a calf, and because the sugar has also been diluted by the water, some kind of sugar must be added to the mixture. The proportions must vary at different ages and in different conditions in order to agree with the child and keep him growing.

The mother must not assume that the child cannot take cow's milk because the standard mixture may not agree with it. It may need less fat or sugar or curd, or it may need more of one of those, or less of one and more of another, to meet its own particular digestive capacity.

For this reason the mother must weigh the baby every week; if it should lose or stop gaining she should weigh it every day. She should watch the bowel movements closely and be able to tell the doctor about them with great exactness, and she should take the baby to a well-baby clinic, or to the best baby doctor she can reach, regularly once a month, and between times if the baby stops gaining or appears out of health. She should follow the directions of the doctor. If she cannot possibly reach a competent physician, she should follow the advice of the nearest public health nurse, or write to the Division of Child Hygiene of her State Board of Health.

Milk is modified by two principal methods, utilizing respectively percentage milk and whole milk. By the percentage method one must use separated milk and cream, or milk whose exact percentage of fat is known. The milk, cream, etc., are combined to duplicate human milk as exactly as possible. This is laborious, uncertain in lay hands, and is seldom employed in ordinary cases. One proprietary food, S. M. A. (Synthetic Milk Adapted), is made by a very exact percentage formula, requiring only the addition of stated amounts of water to be ready for use.[1]

The other and more commonly used method, which is found to agree with most infants, is by simple dilution of whole milk with water and the addition of sugar.

[1] Sellew, Gladys, *Pediatric Nursing*, W. B. Saunders Company, 1927.

Amount of Milk.—In general a baby will need about 45 to 50 calories of food per pound of his normal body weight (or 100 to 110 calories per kilogram—2.2 pounds). This may be attained nearly enough by giving about 1½ ounces of milk per 24 hours for every pound that the baby weighs, providing it weighs about what it should for its age and height. If it is much underweight or overweight a physician's advice should be asked, as otherwise one might overfeed a baby already too fat, or fail to give a puny baby enough to gain on, and it might be a difficult matter to adapt the food to the digestion of an underweight baby. In general, there is a tendency to feed more liberally than formerly.

Morse and Talbot have the following to say about the variableness of the infant's caloric needs:

> In general, babies require from 100 to 120 calories per kilogram of body weight during the first six months in order to gain, and in the neighborhood of 100 calories during the rest of the first year. Most young babies will just about hold their weight on 70 calories per kilogram; a few will gain regularly on this amount, while other babies need as much as 140 calories per kilogram in order to gain. Babies that have been underfed, or that are convalescing from a severe illness whether acute or chronic, need more calories than do normal babies. Babies that are fatter than the average baby will gain on fewer calories than will the average baby. The fatter the baby is, the fewer calories he needs, a very fat baby often needing only 90 calories per kilogram. Conversely, the thinner or more atrophic a baby is the more calories it needs, many extremely emaciated babies requiring as much as 160 calories per kilogram.[1]

Pasteurizing Milk.—There is now considerable difference of opinion concerning the routine pasteurizing of milk. Pasteurizing milk kills most disease germs and also kills the lactic-acid bacillus which causes the normal souring of milk, but putrefactive organisms may survive. Milk which does not sour is not necessarily good milk. Pasteurizing will make milk somewhat safer during hot weather, but dirty milk cannot be made absolutely safe by pasteurizing or any other process, and the word "pasteurized" may give a false sense of security.

Pasteurizing consists in heating milk to a degree which will destroy most disease germs, but will not destroy the essential

[1] Morse and Talbot, *Diseases of Nutrition and Infant Feeding*, 2d ed., The Macmillan Company, 1920.

AMOUNTS FOR DIFFERENT AGES ON BOTH 3- AND 4-HOUR FEEDING SCHEDULE[1]

	Amount for 4-hour intervals, ounces	Amount for 3-hour intervals, ounces
First week	2½	2
Second week	3	2½
Third week	3	2½
Fourth week	3½	3
Second month	5 (or 4 if 2 A. M. feeding is given)	4
Third month	5½	4½
Fourth month	6½	5½
Fifth and sixth months	7	*
Seventh to twelfth months†	8	*

[1] From *Infant Care*, p. 93, U. S. Department of Labor, Children's Bureau.

* After the fourth month most babies are fed at 4-hour intervals, even if they have been fed at 3-hour intervals up to then.

† In the tenth, eleventh, and twelfth months the feedings are of milk unmixed with water or sugar.

vitamins. It is now known that the addition of orange and vegetable juices to the bottle feeding replaces these vitamins; hence there is a present tendency to feed milk which has been brought to a quick boil ("the flash boil") rather than pasteurized.

Sugar is added to the milk as a food and not to give it a sweet taste. The sugars employed in milk modification are: milk sugar; cane sugar; karo; malt sugars such as Bercherdt's, Mead's, etc.; and commercial modifiers such as Mellin's Food, Imperial Granum, Nestle's Food, etc. As the weight per ounce measure of the different sugars varies greatly one should have explicit directions as to the amount *by weight* of the particular sugar used.

Nothing about modifying milk requires nicer judgment than determining the kind and amount of sugar. If too much is used the baby may have diarrhea; if too little he may be constipated (there are many other causes for both constipation and diarrhea, however).

About ⅛ ounce per pound of body weight is the average amount of cane sugar up to a total of 1½ to 2 ounces. No child, at any age, should receive over 2 ounces of cane sugar or its equivalent in 24 hours. As more milk is given, the child gets

more sugar in the cow's milk; therefore the amount of sugar added is decreased as the child grows older and is discontinued when whole milk is given.

Estimating Amount of Food Required.—To estimate the calories to be provided in the day's ration, multiply the number of ounces of milk by 20 (calories per ounce of milk) and the number of ounces of sugar by 120 (calories per ounce of sugar). There is a negligible number of calories in the cereal water. The day's feeding for a young baby weighing 7 pounds would be computed as follows: $7 \times 50 = 350$ total calories. Subtracting 120 calories for 1 ounce of sugar leaves 230 calories which will be supplied by approximately 12 ounces of milk. Diluting this by an equal amount of water gives 24 ounces to be divided into six or seven equal feedings according to the feeding interval.

Orange juice, cod-liver oil, vegetables, and cereals are given to the baby on sweet-milk feeding much in the manner indicated for breast-fed babies (chap. XVI), except that all are given somewhat earlier. The accessory foods must, of course, be figured into the caloric estimates.

Utensils and Their Care.—A certain shelf should be set apart for the equipment used in modifying the milk. Everything used about the baby's milk should be kept by itself and used for nothing else whatever. All utensils should be filled with cold water as soon as emptied, as milk should never dry on anything. As soon as convenient the utensils should be washed in hot water and soap, rinsed and boiled, drained out of the boiling water without wiping, and placed away from dust until used.

Rubber nipples should be rinsed with cold water, scrubbed, and boiled, always taking care to turn them wrong side out and cleanse both sides. They may then be kept dry in a covered jelly glass or other container which has been boiled. Nothing should ever touch the milk which has not been scoured and boiled and kept in a perfectly clean place. The small things may be washed in the saucepan. They should not be washed with other dishes or utensils.

The following utensils will be needed for modifying milk: A 3- or 4-quart saucepan of aluminum or enamel; a tablespoon kept for this purpose only; a glass or porcelain funnel; a measuring glass, or graduate; seven rubber or glass corks to fit the

nursing bottles; seven nursing bottles; a dozen nipples; a bottle brush; a fork.

Preparing the Daily Supply.—In the morning the mother should prepare the entire day's feedings at once. This is an economy of time and saves needless handling of the milk which is always liable to contaminate it.

The mother should scrub her hands and put on a perfectly clean apron before she starts to prepare the milk. She should then assemble everything she is going to use. If she uses bottled milk she should wipe the outside and top of the bottle with a clean cloth, turn the bottle upside down several times to mix the cream evenly with the milk, take the boiled fork and stick one prong into the center of the cap, lift, and stand the fork so that the under side of the cap touches nothing.

She may then pour the necessary amount of milk into the glass measuring cup or graduate, replace the cap, and later place the bottle in the ice box for family use. If the milk is produced at home, fresh milk should be used and prepared at once after the morning milking. After addition of the necessary amount of water and sugar it is stirred well, poured into the saucepan, and brought quickly to a boil. It should boil for 3 minutes, with constant stirring to avoid the forming of scum, or it should be steamed in a double boiler for 15 to 20 minutes. The milk is then poured into the freshly boiled bottles through the funnel, carefully estimating the amount to be poured into each bottle. The sterile glass or rubber stoppers are added, and the bottles may be stood in the saucepan filled with cold water until they are cool enough to put in the ice box. They should be cooled as quickly as possible and kept cold until the moment of using.

Cereal water should be made from flour rather than grain. To make 1 pint of 3 per cent solution, mix 2 level tablespoons of flour with a little cold water to form a paste, then stir this slowly into a pint of boiling water. Cook 20 minutes, stirring well. Water should be added to replace evaporation. Cool and keep cold. Even on ice it should not be kept longer than 24 hours. Cornstarch, oatmeal, barley, or wheat flour may be used.

Acid-milk Feeding.—Digestion in infancy largely depends upon two factors: (1) The gastric-acid producing capacity of the

infant stomach, and (2) the acid-combining power (buffer value) of the food.

Gastric-acid secretion begins when the baby's stomach is empty, and causes, as a result of its irritating effect upon the gastric mucosa, a reflex contraction of the gastric muscle, which, in turn, produces the hunger pain. The hunger pain in infancy is probably more severe than in adult life. The stimulation of the hunger pain may be considered as one of the functions of gastric acid.

The digestibility of any food depends entirely upon its acid-combining property or buffer value. Breast milk, for instance, is said to have a buffer value of 1 which is the optimum buffer value, *i.e.*, the average amount of breast milk taken at each feeding by the average infant just nicely combines with the amount of acid secreted by that infant. Another way of phrasing the condition is to say that the average infant secretes an amount of acid which just nicely digests the average amount of breast milk taken at each feeding.

The acidified cow's milk preparations also have a buffer value of 1 and, therefore, theoretically (and practically) are equally as digestible as mother's milk. Such milks are lactic-acid milk, buttermilk, etc.

Raw undiluted cow's milk on the other hand has a buffer value of 3, *i.e.*, it is only ⅓ as digestible as breast milk. The average baby would have to secrete 3 times as much acid as he does secrete in order to digest raw undiluted cow's milk. Such abnormal secretion is, of course, impossible. Therefore, raw undiluted cow's milk cannot be digested by the average baby. To make it digestible it has to be diluted in the following fashion: Raw cow's milk 1 part, water 2 parts, *i.e.*, a ⅓ milk, ⅔ water mixture in order to have the acid-combining power of the mixture 1, or the optimum.

Boiling cow's milk affects the protein in such a way as to reduce the acid-combining power of the milk. The buffer value of boiled undiluted cow's milk is only 2. So boiled cow's milk has to be diluted with water only once to make it digestible for the average young baby, *i.e.*, a mixture of half boiled milk and half water has a buffer value of 1, the optimum.[1]

For the reasons thus stated a considerable group of pediatricians now feed milk which has been acidified by the addition of lactic-acid bacilli, commercial lactic acid, lemon juice, or orange juice. Some specialists now use evaporated milk in making acid-milk mixtures. In most cities certain dairies now manufacture and dispense standardized lactic-acid milk which

[1] RUPE, *op. cit.*

is prescribed by pediatricians who favor this kind of artificial feeding. Some specialists think equally good results may be obtained by acidifying the milk with orange or lemon juice.

No lay person should attempt to feed an infant acidified milk except under the explicit directions of a physician. The modification must be skillfully adjusted to each child. Many children thrive amazingly on acid-milk feeding, but it does not agree with all.

How to Give the Bottle to the Baby.—When feeding time comes the mother should take one of the bottles, replace the cork with a nipple, and stand it in a pan filled with hot water. It should be tested by letting a few drops fall on the wrist. When it feels warm to the wrist it should be given at once to the baby.



FIG. 64.—The proper way to give the bottle to a baby.

The mother should take the baby in her arms much as if it were going to nurse from the breast, and she should hold the bottle all the time (Fig. 64). She should not prop the bottle up and leave the room, as the baby might strangle, lose the bottle, or suck air from an empty bottle. If the baby draws the milk too fast she should take the nipple out of his mouth occasionally and lift him to her shoulder to enable him to expel swallowed air. If he is inclined to play or sleep she should keep him busy until done. When through taking the bottle she may again hold him against her shoulder and gently pat him until he raises any air he may have swallowed, then lay him quietly down. A baby should never be jarred or shaken after nursing.

Caution.—In traveling, the baby's milk may be carried cold in a thermos bottle. *It should never be carried warm*, neither should the mother try any devices for keeping the baby's milk warm at night in order to save herself the trouble of getting up to prepare it. The mother must never forget that disease germs

grow rapidly in warm milk, and that in spite of every precaution a few germs of a kind that cause bowel trouble may possibly get into the milk and increase to millions within a few hours.

In traveling, a suitcase of suitable size should be set apart for the feeding equipment of the artificially fed baby. This should include the equipment specified with the addition of a quart-size thermos bottle and a sterno outfit. The milk should be modified in the morning, as usual and then cooled and carried cold in the thermos, and the required amount poured out and warmed at each feeding.

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CHAPTER XIX

THE HYGIENE OF CHILDHOOD: FOOD

Wholesomest of meats is bread!
Of sauces milk is wholesomest;
A flowing brook, in gravel bed,
Is of all beverages best;
The heartiest toil gives earth its fruit;
The sweetest music is the lute.

Old Welsh Song.

Feeding after Weaning. *The Daily Schedule from Twelve to Eighteen Months.*—The child may sit at his own little table with his own dishes, pretty colored oilcloth doilies, etc. He should be encouraged to feed himself whenever he wants to do so. A cloth should be given him with which to wipe up his "spills." He will do this happily and will acquire the "complete idea" that spilled things must be cleaned up and that the one who spills is the proper one to clean them up.

Every mother should make a daily schedule for the baby, changing it gradually as the baby grows older, and should follow it strictly. The daily schedule for the child during this period may read somewhat as follows, changing the hours to correspond to the rising hour, which will vary in different families.

1. When the baby first wakes up give him a drink of water; place him on the vessel to urinate; then give him two or three tablespoonfuls of orange juice or tomato juice with cod-liver oil. Let him kick and play or go into play pen until bathed and dressed for breakfast.

2. 7:00 A. M. Breakfast: piece of dry toast, zwieback or very hard cracker (he may have this to chew while the mother is preparing the rest of the breakfast); cereal mush, glassful whole milk.

3. 7:30 or soon after eating. Bowels move.

4. 8:00. Bath (unless he has been bathed when undressed in evening, or before dressing in the morning).

5. 8:15–10:00. In play pen, out of doors if possible. He may have a nap if he awakened early.

6. 10:00. Drink of water; urinate; short walk with mother's help; back in play pen.

7. 11:00. Dinner: dry toast, zwieback or hard cracker; large tablespoonful or more of vegetable mash. One of the following: jellied egg; or cereal mush; or tablespoonful of mealy baked potato with cream or butter and little salt; or junket; or unsweetened custard; or meat broth with rice; or milk soup and crackers; glass of milk (he should usually have one egg yolk each day).

8. 11:30. Urinate.

9. 11:30–3:00. Nap.

10. 3:00. Drink of water, urinate. Lunch: slice bread and butter or its equivalent, glassful of whole milk or butter milk, cod-liver oil in fruit juice.

11. 3:30–5:30. Play pen, sand pile, or ride in baby buggy.

12. 5:30. Drink of water; urinate; visit with mother.

13. 5:45–6:00. Supper: bread and butter with apple sauce, or baked apple, or prune pulp, or cooked ripe pear, or pulp of a sweet orange; glass of whole milk or buttermilk. Or boiled rice with milk, with fruit sauce. Or dry toast with cereal mush and glass of milk or buttermilk, and fruit sauce; or milk toast with fruit sauce.

14. 6:00–6:30. Put to bed.

Some children from twelve to fifteen months will wake up for a drink of milk at 9 or 10 o'clock. The necessity for this will depend upon the weight and general condition of the child and the amount eaten at his regular meals.

Feeding after Eighteen Months. *Frequency of Feeding.*—As has been said, the time at which a child begins to eat with the family will vary according to the convenience of the mother, regularity and spacing of the family meal schedule, the appetite and training of the child, his sleep schedule, and other variable factors. There is a certain advantage in keeping the child on a separate schedule and eating by himself until he can eat neatly and until he is fully adjusted to a three-meal schedule. Most healthy children of eighteen to twenty-four months who habitually start the day with a nourishing breakfast will eat enough food at three regular meals to supply their nutritive requirements and will not need to eat between meals. Until a child can do this it is better to keep him on a four-meal schedule, as it is difficult properly to space mid-meal feeding so that it does not impair the appetite for the next meal.

If it seems advisable to have the child eat with the family and the child does seem to require food between meals, this should be given regularly at a carefully selected time. In many families there is a longer interval between lunch and dinner than

between breakfast and lunch. Where lunch occurs at 12:30 and the evening meal at 6:30, most children should be given a lunch of bread and milk on waking from the afternoon nap.

The important thing is to have a regular schedule. The normal child's body will adapt its functional activity to almost any program which occurs with such regularity that the very remarkable organic rhythms can set themselves to meet the details of the program.

The times at which shifts of schedule must be made are more or less critical times. Changes in the habitual schedule should not be made abruptly for the reason that the cells and organs of the body cannot quickly change in chemical function or nervous response. *They must be given time in which to do this.* The digestive tract will furnish more of one kind of fluid and less of another and have these ready at one time or another time when the new experience has become invariable.

What the Toddler Should Eat.—When the child comes to the family table it is very difficult to prevent him from eating everything which the rest of the family eats. The only way to make the child safe and to avoid conflict is to provide a family dietary on which the child can thrive. Fortunately, this can be done, as the ideal family dietary follows in general the same lines as that advocated for the child.[1]

The Family Dietary.—A dietary which will meet the nutritional requirements of members of the family from two years to four score will follow somewhat the following general form. The varying needs of the manual worker, the young, and the aged can be met by varying quantity and emphasis and the provision of personal "extras" or substitute dishes when necessary.[2]

Milk.—A quart for each child and a pint for each adult should be provided.[3] Crumbine and Tobey say: "A quart of pure milk in some form is desirable and necessary to promote the growth, health, and physical efficiency of every child, at least to the age

[1] Rose, Mary Swartz. *Feeding the Family*, chap. XIV, Food for the Family Group, The Macmillan Company, 1929.

[2] Lanman, McKay, Zuill, *The Family's Food*, chap. V, Food for the Family Group, J. B. Lippincott Company, 1931.

[3] Rose, *op. cit.*, p. 269.

of twelve."[1] A liberal amount of this may be used in cooking, but the serving of a glass of milk to each growing child at each meal should be as much a matter of course as the serving of bread and butter. It is the duty of the mother to see that her family actually consumes this much milk, and it should be her pride and pleasure to study the matter of variety and palatability *and make them like it!*[2] McCollum says, "Milk is the one food for which there is no effective substitute."[3]

Eggs.—Eggs, even at their highest cost, furnish more calories and protein than can be obtained for the same money in any kind of meat which it is safe to give to a child. Egg yolk contains extremely valuable vitamins and minerals which are not found in meat with the exception of the edible organs. It should be the family custom to use eggs at one meal per day in addition to those used in cooking. It is now considered desirable that the growing child have one egg yolk daily on account of the availability of its iron and the presence of vitamin D.

Meat.—There is a wide difference in opinions as to the age at which children may properly be given meat. As a matter of fact the child need never have meat if he has a full milk and egg quotient, but bits of choice cuts of chicken, fish, scraped beef, and mutton chops may be given with safety even to a very young child, providing the meat is finely chopped and given in small amounts. Liver is rich in iron, vitamins, protein, and other minerals and is now included in most diet lists for even very young children. A very little finely scraped steamed beef liver may be given the child occasionally. Liver is often prescribed for anemic children. When it is used on the family table a portion should be especially prepared for the child, who, of course, must not have fried liver.

Cured meats such as smoked or preserved meat (with the exception of crisp bacon), tough-fibered meats such as hamburger, highly spiced meats such as sausage, and greasy or indigestible meats such as pork or veal should never be given to young

[1] Crumbine and Tobey, *The Most Nearly Perfect Food*, p. 108, Williams & Wilkins Co., 1929.

[2] *Ibid.*, chap. IX, Milk and Good Cookery.

[3] McCollum, E. V., *The Newer Knowledge of Nutrition*, p. 149, 2nd ed., The Macmillan Company, 1922.

children. When or if the family elects to indulge in these meats a special portion of some appetizing substitute must be served to the child.

It is now pretty widely accepted that meat is to be used for variety and to satisfy personal preference and not because it is a necessity. The judicious use of meat to give flavor to soups and other foods, and to furnish the essential amino acids which are lacking in vegetable proteins such as beans, macaroni, etc., is to be commended. Most families now seem to find that these various needs are met by the use of meat two to four times per week, and never oftener than once per day. The "lacto-ovo-vegetarian" diet in which no meat is used, but milk and eggs are used freely, has some enthusiastic advocates.

Grains, Cereals.—It has been explained that the important vitamins and minerals are found in the germ and next to the hull of grains and seed vegetables. White flour and hulled cereals contain very little except starch and a variable amount of protein in the form of gluten. These substances are perfectly digestible and valuable for energy, but seriously lacking in the materials of growth, particularly vitamin B. The growth factors *can* be added in milk, fruit, and vegetables, but very few dietaries *do* include enough protective foods to replace entirely the important factors removed in milled grains. There was a period of alarm over an announcement from Mellanby's laboratory that cereals, notably oatmeal, contained a toxic or anticalcification factor which was ricket-producing. This seems to have been conclusively disproved.[1] Every family should use whole-grain breads and cereals, if not exclusively, at least to a large extent, in order to safeguard the teeth, bones, and blood of all members, old and young, but especially the appetite, digestion, and development of the growing child.

The family which uses an adequate milk ration and whole grain breads and cereals has established a very sound basis for the nutrition of all of its members.[2] These two items are of especial importance to the family which uses a low-cost dietary. No mother should say that she "cannot afford to buy milk" for

[1] *Third Conference on Research in Child Development*, Part I, pp. 52–53, National Research Council, Washington, D. C., 1929.

[2] McCollum, *op. cit.*, p. 149.

her family.[1] Milk is the one thing she cannot afford to curtail or omit. And it must be remembered that "Bread is the staff of life" was written in the days when nothing was known but coarse, wholegrain breads which actually did contain most of the essential vitamins and minerals.

Vegetables.—We eat the roots, tubers, seeds, and leaves of plants. Of these, only seeds contain any important amount of protein. Beans, ripe peas, lentils, peanuts, and cereal grain all contain protein. Certain essential amino acids are lacking in these proteins and must be added by combining milk, meat, or eggs with these (see page 164). When combined with a small amount of animal protein, seed vegetables may be used as meat substitutes in the family dietary. Some of these are rather difficult to digest, however, and must be given to small children with caution.

Root and tuber vegetables when properly cooked furnish many of the essential minerals and growth vitamins, and also provide carbohydrates or energy foods and cellulose or roughage. This class of vegetables should be used liberally on the family table, especially the yellow roots and tubers (see page 183).

Leafy vegetables are now considered to be indispensable in the human dietary on account of their vitamin and mineral content. Since some vitamins are destroyed by open heat and minerals are dissolved and drained away in water, these vegetables should be used in raw or lightly cooked state, or waterless vacuum methods of cooking employed.

Raw leafy vegetables and salad vegetables such as carrots, celery, etc., may be chopped fine, lightly salted, and spread in bread and butter sandwiches. This may be served to the toddler instead of the richer salad served the family. Mixing several vegetables in this manner adds variety and obscures the flavor of strong vegetables. In many nursery schools, the vegetable sandwich is a regular item of the menu. Finely chopped raw vegetables may be added to gelatin. This combination is always popular with children.

Cabbage is more generally available in the winter when other fresh leafy vegetables, especially in the country, are scarce and high in cost. Every mother should make a study of serving

[1] CRUMBINE and TOBEY, *op. cit.*, p. 169.

this important vegetable in wholesome and varied ways. All the members of the family should be trained to eat fresh, raw vegetables freely. It will be found that they will then have much less liking or craving for pickles, condiments, and highly spiced relishes.[1]

Fruits.—Fruits are important because they contain vitamins and minerals, also carbohydrate in the form of sugar and cellulose. They are especially important to young children because of their high sugar content. The toddler needs energy food in abundance on account of his great activity. The best way for him to get it is in fruits, root vegetables, and cereals. The child who eats fruit freely every day should not crave candy and pastry. The same thing is true for the entire family. The mother of our child should serve fruit desserts in abundance; always serving fresh fruit in some form for breakfast, and should keep a bowl of apples on the table for all meals when apples are in season. She will find that her family, when fed in this manner, will willingly excuse her from pastry making, there will be no conflict with the toddler on this point, the meals will cost no more, and the health of all will be conserved.

Potatoes.—In the American dietary, the potato occupies a unique place. It is the universal "filler" which, together with bread, contributes much of the bulk of the meal. The potato is chiefly starch, but it does contain vitamins, and near the skin is a rather important amount of minerals; it is alkali-producing and thus affords an important balance or "buffer" to the acid-producing cereals, meat, and bread of the usual dietary. On account of the high starch content of this vegetable the meals of the average family will be better balanced if potatoes are served not over once daily. Of course a method of cooking which conserves the mineral content, such as baking or boiling in the skin, is to be preferred. Fried potatoes should not be served to the toddler for reasons explained on page 168. Rice is acceptable as an occasional substitute for potatoes, but rice and potatoes should not be served at the same meal.

If the homemaker is resourceful in preparing the foods here indicated in varied, palatable, and attractive ways she will find

[1] Bookoven and Pittman, Economy of Cabbage, Carrots, and Spinach, *Journal of Home Economics*, September, 1931.

that her family, from toddler to grandmother, can safely eat at the same table and all will enjoy their food and thrive upon it.

Special Points in Feeding Young Children. *Water.*—The child should be given plenty of water to drink between meals and always from his own cup. Unless one can be perfectly sure of the water supply it should be boiled and cooled. Children sometimes fret for food when they are really thirsty rather than hungry but do not know how to state their discomfort.

Eating with Clean Hands.—From the very first the baby's hands should be washed before he handles his bread and food. This is important because babies handle everything and may contaminate their food. It is also important from the standpoint of training in future health habits. Well begun is always more than half done in the matter of child training. The child who has never known anything other than eating with washed hands will be so thoroughly conditioned that in later childhood it will at least be less often necessary to send him away from the table to perform this rite! The baby should never be permitted to pick up food or anything else which has dropped on the floor and put it in his mouth again. While he is struggling with his first crusts he may be placed in the middle of a clean surface on a bed or on a clean sheet spread upon the floor or in his play pen; then someone should watch that he does not get his food dirty and that he does not choke.

Proper Seating at Table.—When the child begins to eat at the table he may then have a "youth's chair" or may have a small box placed on an ordinary chair. He should always have some place to rest his feet. Children are often restless and hard to control at the table simply because they are weary and uncomfortable. A little step may easily be added to any ordinary chair. If a youngster has eaten at his own small table until he is two or three he will never need to use the dangerous high chair which is so easily overturned.

Variety and Palatability.—If the child is fed a variety of well-cooked, appetizing food suitable for his age, it will be a long time before he will trouble much about what the rest are eating unless the matter is suggested to him or discussed before him. Children frequently turn against wholesome and desirable articles of food because they are so badly prepared that an adult could not enjoy

them, and presented so continuously that the child becomes bored. It is better to stop offering for a time and then present in a new form than to attempt to compel the eating of that which is distasteful.

Sweets.—Honey and molasses may be used with moderation. These are natural sweets, which also contain some minerals and vitamins and have some laxative effect. If the child has these occasionally, with plenty of fruit and simple desserts, he will need little other sugar. Sugar should be used *sparingly if at all* on cereals or fruits, except for a little on tart fruits. It is much better to teach the child to like the fine natural flavor of the different cereals, fruits, and vegetables than it is to have to "bait" everything with sugar to get him to eat it. Sweets between meals impair the appetite and favor tooth decay because of the acid-producing effect, which tends to soften the dental enamel. Sweets are habit-forming and tend to create a craving for sweets in excess.[1]

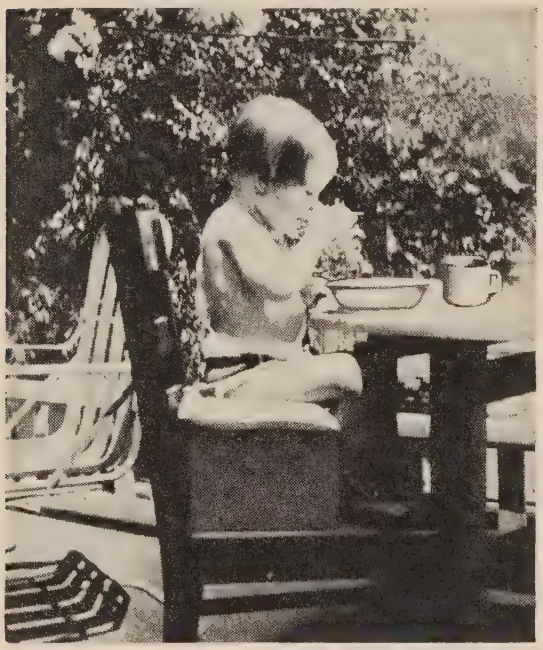


FIG. 65.—An improvised high chair.

The longer the child can be prevented from having his first bite of candy the better. It would be better if he never made its acquaintance.

Things a Growing Child Should Never Eat. *Any Food in Which Starch Is Coated with Grease.*—As stated on page 168, all starch is partly digested in the mouth while it is being chewed. No other digestive fluids act upon the starch until it reaches the bowel. If starch is coated with grease the saliva does nothing to it and the bowel must do it all. This is hard upon anyone's digestion, but especially that of a small child. For this reason, flour gravy, pie crust, doughnuts, fried potatoes, or any other fried food should never be given to a child.

[1] ROSE, *op. cit.*, p. 183; H. C. SHERMAN, The Problem of Sweets for Children, *Bulletin of the American Child Health Association*, May, 1929.

Anything It Cannot, Will Not, or Does Not Chew.—Corn, cucumbers, radishes, pop corn, nuts, tough meat, etc., are examples of food unsuitable in this respect.

Highly Flavored, Seasoned, or Spiced Foods.—It is a serious mistake to give young children food flavored with pepper, spices, vinegar, or highly sweetened food. This includes sausage, wienies, pickles, relishes, preserves, mustard, etc., which soon destroy the child's liking for simple, wholesome food and start endless trouble and capricious refusal to eat what he should eat. Such things use an enormous amount of digestive energy to no purpose, since they have little or no food value.

Pancakes, biscuit, or soft fresh flour bread of any kind which forms a dough-like bolus which cannot be properly mixed with digestive secretions. The test of proper bread is that it crumbs when mashed between the fingers. Bread which forms a soft, sticky mass when rubbed between the fingers is unsuitable for small children.

"Treats" between meals such as pop corn, peanuts, candy, pop, ice-cream soda, etc., not only do a child no good whatever, but actually do him much harm by spoiling his appetite, overworking his digestive organs, and making him difficult to manage. Above all, a child should never be "bribed" with these things. Ice cream is a wholesome food when used as part of a meal. It should not be given between meals.

The Importance of Breakfast.—Breakfast is the key meal of the day. If the child does not eat enough breakfast he is cross and hungry in an hour or two and fusses until he is given a "piece." Then he is not hungry for his noon meal, and must have another "piece" in the afternoon. This soon becomes a daily occurrence and will make any child irritable, spoiled, and subject to indigestion.

Why Children Do Not Want Breakfast.—1. Indigestible food the evening before. If the digestive organs have had to work all night they are not yet ready to care for another meal.

2. Eating too soon after rising. A child who is brought from his bed to the table in his night clothes, or scarcely awake, cannot be expected to eat. Every child should have a drink of water on waking, and then be quickly bathed and dressed and given a few moments to play, out of doors if possible, before being served with breakfast.

3. Unappetizing food. Too often the child who sleeps late is expected to eat cold, unappetizing food. No matter how busy the mother is, nothing can possibly be so important as the matter of serving a fresh, well-balanced morning meal to her growing children. In the long run she will save time by doing this, as the well-fed child will be happy and will not disturb her later by teasing for a lunch.

Preparation and Care of Food. *Milk.*—Unless certified grade A raw milk can be obtained, it is better to measure out enough fresh milk in the morning to last all day, put it on the stove, and bring it quickly to a boil (it should not bubble for longer than 2 minutes); cool it quickly, and keep it on ice. *It must be kept cold from the moment of milking except for the period of heating.* Just what is needed is poured out at each meal, and the child's cup should stand in hot water to take off the chill before it is given to him. Ordinarily the child should be given plain whole milk. The cream should be thoroughly stirred in before taking out each feeding. Part of the cream should be removed from Jersey milk, or any milk with high fat content.

Zwieback or "twice-baked bread" is made by baking sliced bread in a quick oven until a delicate brown.

Cereals.—Whole-grain cereals should be used very freely in the feeding of growing children. The refined and prepared cereals have had much of the most valuable parts removed. Children should be given a variety of cereals. Oatmeal may be the standby, but some other cereal should be used at least two or three times per week in order that the child may not become tired of the sameness of his diet.

Cereal Gruel.—Sprinkle oatmeal, corn meal, barley, cream of wheat, farina, rice flakes, or other uncooked cereal in enough boiling water to make gruel about as thick as ordinary flour gravy when done (the amount of water varies with different grains). Boil hard for 3 minutes, then put in double boiler and cook for 1 hour or longer; add ¼ teaspoon of salt to each cup of gruel. Strain through a fine sieve. All cereals with hulls should be rubbed through a sieve before they are given to infants under one year old.

Cereal Mush.—Cereal mush should be about as thick as mashed potatoes. Cereal mush may be wet with a small amount of

cream or milk, but should be fed to children thick enough to encourage some chewing. If properly salted in the making, the mush will have a good flavor and will not need the addition of either salt or sugar to make the child like it.

Vegetable Water.—Take one cup each (finely chopped) of two or more of the following vegetables: spinach, carrots, celery, tomatoes, string beans, green peas, dandelion greens, young turnips, young turnip tops, cabbage, or other tender root or leafy vegetables, add water to cover and cover tightly; cook slowly until vegetables are barely tender. Overcooking destroys vitamin C. Boiling water should be added as fast as it boils away. The water should be drained through a fine sieve and a little salt should be added.

This kind of vegetable extract is often prescribed for delicate and anemic infants and may be added to the diet of any child. Modern pediatricians often advise adding vegetable water to the infant's drinking water once or twice daily. It is especially rich in iron, potassium, and other minerals. Blending the flavors of several vegetables tends to prevent the child from acquiring dislikes of certain vegetables of strong flavor.

Vegetable Mash.—Make as for vegetable water, but allow water to evaporate and strain pulp through a coarse sieve. All fiber and coarse parts should be strained out for small children.

Dr. Bundesen gives the following directions for preparing food for a six-months-old child:

> Several kinds of leafy vegetables are chopped, six tablespoons cooked in closed vessel with very little water. Two tablespoons of potato with carrots or other root vegetables cooked separately; one tablespoonful of rice, cooked separately; one tablespoonful scraped calf's liver. All these are mixed, rubbed through 18-mesh sieve. The infant is given all he will eat of this mixture followed by milk.[1]

This bland mixture may serve a useful purpose in establishing tolerance of the various foods. The child should promptly be offered individual foods, however, in order that he may not become "conditioned" to any inconvenient and artificial type of food mixture.

Fruits.—All fruit given to young children should be perfectly ripe and fresh. Only ripe, sweet oranges should be selected for

[1] Bundesen, Dr. H. N., Our Babies, p. 18, *Chicago Daily News*, 1926.

the juice given to infants. Only perfect fruit should be given to any young child. Canned tomato juice may be used if good brands are selected in which only choice ripe fruit was originally used.

Prunes and other dried fruit should be carefully selected; only fruits which were choice and ripe when dried should be cooked for small children. Bananas are nutritious and easily digested if fully ripe. The skin should be black, but the pulp firm and fresh. The high caloric content of bananas should be considered; otherwise the child may be overfed.

To Cook Prunes or Other Dried Fruits.—Wash thoroughly, cover with water; soak over night or for one or more hours in aluminum or porcelain-lined pan; place on stove *in the same water;* simmer very slowly until the water is syrupy and the fruit soft.

For a baby under six months old, strain off the juice only. For one over six months rub the pulp also through the sieve. Dried fruit requires no sweetening. Ripe dried fruit, cooked as described, will develop its own rich sweet syrup. Apples, pears, or ripe bananas when baked form wholesome articles of diet for even very young children. Prunes may cause loosening of the bowels; they should therefore be used with caution. Prunes are often given because of the laxative effect where there is tendency to constipation.

Eggs.—Coddled or soft-poached eggs are prepared by dropping the egg (with or without the shell) into boiling water, covering closely, and removing from the fire. Remove from the water when of a jelly-like consistency. The yolk of hard-boiled eggs is easily digestible and may be fed to any child who is permitted to have egg. Hard-boiled white of egg should not be given to a child.

Feeding Problems. *The Child Who Will Not Drink Milk.*—Children may refuse milk for any of the following reasons:

1. Bottle-fed babies who have been fed on sweetened condensed milk, or milk modified with too much cane sugar, are apt to refuse plain unsweetened cow's milk.

2. Children who nurse the bottle or breast too long sometimes refuse to drink milk from a cup.

3. The mother may at some time have given the child milk which tasted or smelled of onions, cheese, fish, or some strong food which had stood near it; or the milk may have been tainted by the cows having eaten wild onions or some strong herb in the spring pasture; or the milk may have at some time begun to turn sour.

4. The child may have been spoiled by having been given sweetened drinks, cocoa, and highly flavored food, which he naturally prefers to the mild-flavored milk.

5. The child's diet is permitted to become monotonous and unattractive. He craves a change, and the only way he has of expressing this is to refuse the things he has had continuously. *The child will drink milk continuously, just as he eats bread at every meal, if he is given a variety of other things.*

6. The child is permitted to become capricious and undisciplined. This kind of child never feels well and is capricious about his food as well as everything else. *The answer to this is a course in child study for the mother and never punishment for the child.*

7. The commonest reason is the failure of the mother to realize the importance of a full milk ration for every growing child. After the child has once been permitted to stop drinking milk it becomes very difficult to retrain him.

The Child Who Craves Meat.—Any person who does not eat a sufficient amount of milk or milk products or eggs will crave meat. Everyone should have some animal food every day. The child who does not have a full milk ration every day craves other animal food to take its place.

It would be very dangerous to give the child enough meat, cheese, and eggs or beans to furnish him the same protein value as the quart of milk he should have every day. A quart of milk will give the child as much material for growth and energy as he would secure from seven eggs or two pounds of chicken. He needs this much growth material, but no one would think of feeding a child this amount of meat or eggs.

It is practically impossible for any child to make a normal, healthy growth without a reasonable amount of milk. If the child actually drinks a cup of milk at every meal and receives

some besides in the cooking, with an egg or cottage cheese occasionally, he will not be apt to crave meat, and will do well with little or no meat. On the other hand *no child should be permitted to live on milk to the exclusion or limitation of solid food.*

The Child Who Refuses to Eat New Food.—This situation again is more easily prevented than corrected. Unless a child has had an unpleasant experience connected with the tasting of new substances, he will naturally be responsive to the suggestion that "here is something new and good to eat; mother is *sure* baby will like it." Then be sure that the new substance is delicately prepared and appetizing, and *offer it when the baby is actually hungry.*

When giving new vegetables, especially those having decided flavors, give small bites with crumbs of bread or toast, or mix with potato, in order to allow the child to become gradually accustomed to the new taste.

Every care should be taken to prevent the child from hearing others discuss any wholesome article of food unfavorably. The mother should try to bring up her children without prejudice against anything not harmful. It should be a basic item in family training to avoid discussing any food unfavorably at the table.

The Child with a Poor Appetite.—The child who is constipated, who has large adenoids, diseased tonsils, bad teeth, who gets too little sleep, or who does not have enough outdoor life and fresh air, or one who eats irregularly or capriciously, is likely to be finicky and delicate about his eating. The child who eats too often or who is stuffed on dainties, or who is harried and nagged by a nervous mother, will not eat well. The child who does not get enough vitamin B, or in other words, enough fresh, protective food will be undernourished and lack appetite (see page 190). Lack of appetite may be due to such poor general tone that the muscles of the stomach even are sluggish and the stomach does not promptly empty itself.

A child who does not become hungry when strictly limited to three good wholesome meals per day should have his sleep schedule lengthened, also his time for fresh-air play. If he still fails to eat he should be examined by a physician and have his defects, if any, corrected.

A child should never be forced to eat when he is not hungry. It is more sensible and humane to find and correct the cause. Besides, conflict only intensifies the situation and piles up trouble.

The Psychology of Feeding.—The attitude of the child toward food and feeding is all-important. We now know that *the child acquires these attitudes very early* and that they are very persistent. We need to recall the fact that his environment is constantly establishing new gradients in his flexible protoplasmic and nervous structures and that these tend to become permanent and difficult to eradicate. It is not only important that the child shall eat the foods required for his optimum growth, but it is of even more importance that *he shall like them and prefer them,* as only in this way will he be sure of continuing to eat them after he becomes old enough to choose his own food.

We now know also that aversion to food interferes with digestion, and that forced feeding may not only bring about injurious inner nervous conflict but may cause actual illness and prolonged malnutrition. Instead of establishing gradients for permanent use and enjoyment of desirable foods, gradients are established for permanent dislike. This defeats the very purpose of the parent.

With these facts in mind we can appreciate the importance of helping the child to establish the right feeling and attitude toward foods when first presented to him. We can also appreciate the importance of avoiding the establishment of likes and dislikes and attitudes which must be corrected later if the child's welfare is to be conserved.

Establishing Good Habits.—Most of the practical points involved in the psychological management of feeding have already been mentioned in this chapter. Briefly these points are:

1. Regularity such that physiological adjustments or rhythms can be established.

2. Variety such that the child does not become tired of a few staples like bread and milk.

3. Balance such that the child does not develop obscure physical cravings and caprice because his tissues are actually hungry for food factors he is not receiving.

4. Matter-of-factness about meals and foods. The taking for granted that everyone is going to eat what he should eat does much to prevent conflict.

5. Family harmony as to likes and dislikes. If any adult has food aversions, it should be a matter of family policy to avoid calling the attention of the child to these in any way.

6. Good cheer at table. Mealtime should be a happy time. Unpleasant matters must never be discussed at the table, and, above all, matters of discipline should never be discussed or administered during the meal hour; scolding and nagging and teasing should be taboo. A funny-story contest at mealtime is a splendid custom. Experiments with animals show that the secretion of digestive juices is arrested and that digestion actually ceases when an animal is frightened or teased or becomes angry and emotionally disturbed.

7. An intelligent understanding of food values and nutrition and a practical knowledge of good cooking are essential, of course, in making the balanced ration appeal to the family. The mother of young children should constantly read new literature upon these subjects and participate in extension courses or group activities relating thereto, and avoid falling into a rut of monotonous repetition in food selection and preparation.

Breaking Bad Food Habits.—The best way is to let go, stop all conflict, and begin all over again.

1. Change the atmosphere. The change must be utter and entire—not an irritable or insistent or coaxing or nagging word! Nothing disarms resistance like this and nothing short of this will disarm resistance.

2. Take desirable responses for granted. Serve the child as matter-of-factly as other members of the family. If, as has been indicated, the other members do eat what he is supposed to eat and do it as a matter of course, he will tend to fall in line. He must be treated with the same courtesy and consideration as prevails among the adults.

3. Give him time in which to make readjustments. He cannot abruptly change either his mental or physical responses. He must have time to forget the old situation. In order to do this he must not be reminded of it. He must be served with a balanced ration but one which differs somewhat in appearance and

flavor from the articles of most frequent former conflict. This should be done smilingly, without discussion or argument. If he does not eat it there is still no fuss or argument, and especially is it usually, though not always, unwise *to make substitutions* at the time of refusal. The child will quite naturally prefer to make a selection if he discovers that he can secure it by negative behavior. It will not hurt any child to miss a meal or to eat lightly for a few meals. Hunger is the best sauce. Many children remain capricious and difficult because the mother yields to demands for irregular feeding, especially of sweets, and the child never knows the sensation of healthy hunger. If the child shows need of food before the next meal he may be given milk or bread and milk or other simple, bland food, quietly and in a cheerful, matter-of-course way. If possible leave the child alone with the controversial food so he will not have the humiliation of having a witness to his capitulation. If this food is refused take the refusal casually but offer nothing else.

4. Ignore all emotional explosions. Divert the attention of the child to other interests if possible, but remain serenely deaf to teasing, screaming, stamping, and tantrums. Give the child time to learn that there is a new and inflexible order of things and that such methods will not bring him the desired results. *This involves time and especially patience.* The mother must continually remind herself that the situation was of her own making and that she cannot undo it in a twinkling.

Such in general is the way in which nursery-school children are trained and retrained. Children are highly sensitive to atmosphere. An atmosphere of dictatorial, irritable insistence, and, equally, an atmosphere of sentimental coaxing, and especially the combination or alternation of the two, will make any normal child negativistic and stubborn. An atmosphere of inflexible but cheerful taking of cooperation for granted tends to make almost any child cheerful and cooperative in time.

Above all, the mother must not let the child know that she is solicitous or worried about his nutrition. She should protect the child from the concept or suggestion of illness just as long as she can.

The idea of health, however, may be presented to him in very simple terms as he becomes able to understand. It is a

very wrong method to try to scare a child into eating spinach or drinking milk by telling him he will become ill or thin or ugly if he does not. This only deepens aversion and keeps an undesirable thought-image before his mind and imagination.

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CHAPTER XX

THE HYGIENE OF CHILDHOOD: SLEEP

Baby, baby bright,
Sleep can steal from sight
Little of your light:

Soft as fire in dew,
Still the life in you
Lights your slumber through.

Four white eyelids keep
Fast the seal of sleep
Deep as love is deep:

Yet, though closed it lies,
Love behind them spies
Heaven in two blue eyes.

ALGERNON CHARLES SWINBURNE.[1]

The Physiology of Sleep.—Science is still unable to explain the phenomenon of sleep. The fact that in all nature the period of sleep ordinarily coincides with the period of diurnal darkness seems to indicate that sleep is an evolutionary adaptation. This does not, however, explain the essential and indispensable relation of sleep to life. There are several theories as to the cause of sleep, no one of which is supported by conclusive proof. It is more likely that the process is exceedingly complex, and that all the causes assigned are involved, and doubtless others.

It has been suggested that sleep is purely a chemical matter due perhaps to cumulative acidosis, to depletion of intramolecular oxygen, to accumulation of fatigue toxins, etc. Another theory is that the synapses (see page 426) between the cortical brain cells and the fibers in the nerve paths communicating with the rest of the body become temporarily discontinuous—switched off, as it were. A third theory is that the blood supply to the cerebral cortex is periodically diverted, producing a temporary anemia.

Among the body functions, tissue metabolism, food digestion, and body temperature do not markedly vary in sleep from the waking state; muscle tone, pulse rate, and higher reflexes are diminished.

[1] "Cradle Songs," *The Poems of Algernon Charles Swinburne,* Gabriel Wells, 1925.

Growth and Sleep.—The animal grows while it sleeps. The infant sleeps most of the time and accomplishes the prodigious feat of doubling his weight during the first five or six months of his life. It will be noted that the sleep curve in Dr. Bühler's investigation of sleep resembles closely the curve of normal growth for the first year as shown on page 66. No child who sleeps less than his system demands will achieve his full potential growth. A period of sleep reduction because of excitement or fatigue may register in the weight curve as definitely as does digestive disturbance. Experimental animals bear loss of sleep less well than loss of food.[1] The energy expenditure is greatly reduced during sleep. The body is not made to withstand constant activity. It must rest.[2]

Bodily Activity during Sleep.—An investigation of sleep (the Simmons Study) has been in progress for some time in the Mellon Institute of Industrial Research of the University of Pittsburgh, partial reports on which have appeared from time to time. One of the interesting discoveries thus far reported is the fact that no one "sleeps like a log." Even a more than ordinarily quiet sleeper changed his position radically 33 times in 8 hours and 25 minutes.

These investigators say that muscle tire, visceral pressure, the increased heat on surfaces of contact with the mattress (reaching 96° in 20 minutes), the tendency of muscle colloids to gel under complete inactivity—all make frequent movement imperative to bodily comfort and well-being.

Not only is the frequency of movement significant but also the range of movement. On a level bed an individual sleeping alone tends to assume symmetrical attitudes in turn such that he relieves each side and each part of his body in succession and equally.[3] The individual who sleeps with another person is more or less restricted in the range of his movements, and he is unable to relieve fatigue and tension of all parts of his body to the natural and complete extent.

[1] Manaceine, Maris de, *Sleep; Its Physiology, Pathology, Hygiene, and Psychology*, p. 65, Walter Scott, London, 1897.

[2] Rose, Mary Swartz, *The Foundations of Nutrition*, p. 59, The Macmillan Company, 1927.

[3] Johnson and Sevan, Sleep, *Psychological Bulletin*, January, 1930.

These observations support the commonly stated rules of sleep hygiene to the effect that the young child should sleep alone and that he should have the same complete freedom of movement during sleep that he requires when awake.

The following tables give the result of the observation on more than one hundred subjects.[1]

AVERAGE REST PERIODS OF HEALTHY PEOPLE (DURING SLEEP), IN MINUTES

Age	Most active individual	Least active individual	Most typical individual
Children two and one-half to four years	5	10	7
Unselected college men	7	22	13
College athletes (varsity) during playing season:			
Basketball players	8	15	11
Football players	7	12	10
Middle-aged men	6	13	9
Wives of middle-aged men	8	15	11

There is a prevailing belief that the healthy infant or small child sleeps profoundly and with little movement. Actual observation seems to show that even the new-born child has relatively short intervals of profound slumber and makes many movements during sleep, even though sleeping occupies most of his total time. Dr. Charlotte Bühler of Vienna, in a very detailed report on the behavior of children during the first year of life, comments on the relatively short sleep intervals, and while she does not present a tabulated report of this matter, her individual schedules present a picture in accord with the American observations as to activity during sleep. For example, the observation of a new-born boy contains the following comments in succession as to sleep activity during the first two days life:

Trembles as the cover is momentarily removed, makes several restless movements. . . . Moves in his sleep without outside reason. . . . Opens his mouth while asleep. . . . Aimlessly he moves his arms up

[1] JOHNSON, H. M., How Should Healthy People Sleep? *Good Health*, September, 1930.

and down his face. . . . Impulsive movements of the arms interrupt the immovability of the child. . . . Moves arms, makes sounds of discomfort, moves lips in sucking fashion without opening his eyes for a moment. Quietly he continues sleeping. . . . Moves his head restlessly, begins to cry lightly, sleeps on. Rubs his face with his fist, lifts covers with his hands restlessly, continues to sleep. . . . Makes a slight sound, the hands move restlessly, sleeps on. . . . Breathes deeply, turns his head, sleeps on. Makes a few restless movements in his sleep. . . . [1]

Dr. Bühler comments on the fact that the sleeping periods of the new-born were unexpectedly brief and gradually increased in length during the first year. She says that the average number of sleeping periods per 24 hours in the first quarter of the year amounts to 12, in the second to 11, in the third to 7, and in the last quarter of the first year of life to 6. She found in all children a surprising number of very short sleeping periods of only a few minutes each.

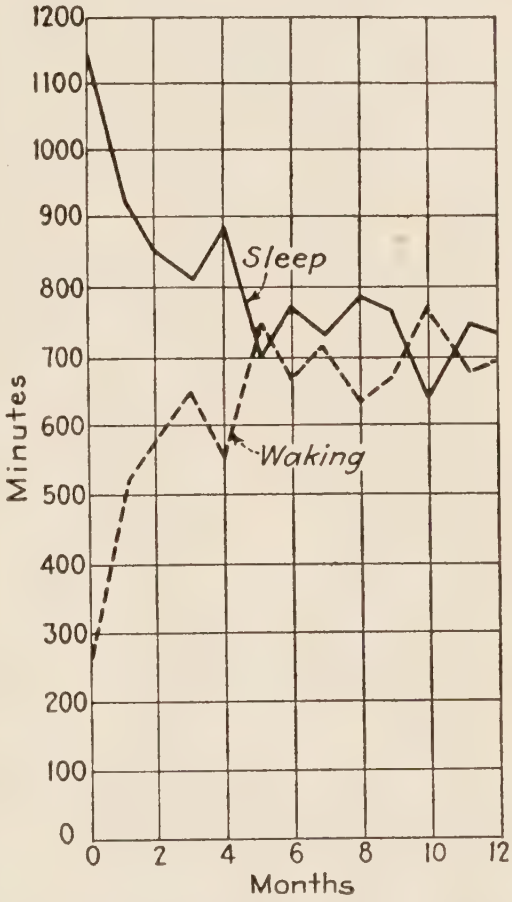


FIG. 66.—The day value for sleep and waking in minutes. (*From Charlotte Bühler, The First Year of Life. John Day Company.*)

How Much Sleep.—It is only recently that actual research has been initiated as to the definite sleep needs of children. There is as much individual variation in this as in food, exercise, and all other physiological functions. However, certain basic similarities enable us to make general rules which fit the majority of cases, just as rules have been made concerning the use of milk and eggs, although these have to be modified for the exceptional child. In general, the investigations which have been made of the actual sleep habits of young children in the nursery

[1] BÜHLER, CHARLOTTE, *The First Year of Life*, pp. 114–115, John Day Company, Inc., 1930.

schools of Chicago University, Toronto University, Minnesota University, and elsewhere[1] show that these children actually sleep less than has been declared to be theoretically desirable. It remains to be determined by carefully controlled observation what is the *optimum* amount of sleep under varying ages and circumstances.

Dr. Bühler found that the new-born spend 80 per cent of the average 24 hours in sleep and that this decreases to 49 per cent at one year. The following table gives the result by bimonthly intervals in percentage,[2] while the chart expresses the same in a time-age graph.

THE DURATION OF THE WAKING AND SLEEPING STATES WITHIN 24 HOURS, IN PER CENT[1]

Age in years and months	0;0	0;1–0;3	0;4–0;6	0;7–0;9	0;10–1;0
Sleep	80	60	55	53	49
State of waking	20	40	45	47	51

[1] Charlotte Bühler.

The Children's Bureau of the U. S. Department of Labor, in the bulletin on infant care says that,

> A very young baby should sleep from 20 to 22 hours out of 24; during the second and third months about 18 to 20 hours. When the baby is six months old he should sleep about 16 to 18 hours—12 hours at night with only one interruption for a feeding and 2 or 3 hours in the morning and 1 or 2 hours in the afternoon. . . . At six months of age the afternoon nap should not last later than 3 or 3:30, lest it keep the baby from sleeping at night.[3]

A study of the sleep of young children has been made by the Institute of Child Welfare of the University of Minnesota in order to determine the amount of time spent in sleep by children

[1] BOYNTON and GOODENOUGH, The Posture of Nursery-school Children in Sleep, *American Journal of Psychology*, vol. 42, 1930; also CHANT and BLATZ, A Study of Sleep Habits of Children, *Genetic Psychology Monographs*, July, 1929; The Simmons Sleep Investigation, *Journal of Home Economics*, May, 1930.

[2] BÜHLER, *op. cit.*, p. 130.

[3] *Infant Care*, p. 38, U. S. Department of Labor, Children's Bureau Publication 8, Washington, D. C., 1933.

between six months and eight years of age. Data obtained from the records of 1,186 children over a period of 7 days in October, 1927, show the mean total sleep during 24 hours for children from six months to one year to be 14 hours, 1.4 minutes; from one to one and one-half years, 13 hours, 22.4 minutes; one and one-half to two years, 13 hours, 21.1 minutes; two to two and one-half years, 12 hours, 48 minutes; two and one-half to three years, 12 hours, 29.5 minutes; three to three and one-half years, 12 hours, 16.8 minutes; three and one-half to four years, 11 hours, 57.5 minutes; four to four and one-half years, 11 hours, 48.8 minutes; four and one-half to five years, 11 hours, 36.7 minutes; five to five and one-half years, 11 hours, 22 minutes; five and one-half to six years, 11 hours, 9.9 minutes; six to six and one-half years, 11 hours, 4.4 minutes; six and one-half to seven years, 10 hours, 57.3 minutes; seven to eight years, 10 hours, 55 minutes. The mean amount of sleep is thus seen to decrease with advancing chronological age and is definitely lower than that recommended by most writers. No sex differences are shown.[1]

At the Washington Child Research Center observations are being made of the sleep of nursery-school children. A unit of 34 children who were checked for 30 days showed that the average night's sleep for two, three, and four-year-old groups was nearly the same. The two- and three-year-olds averaged 11 hours and 6 minutes, the four-year-olds, 11 hours and 2 minutes.

In the Washington study just quoted it was found that the older children went to sleep more quickly than the two-year-olds, the latter requiring an average of 27 minutes while the three- and four-year-olds required an average of 20 minutes.

The correlations indicate that the later the children were put to bed the longer it took them to go to sleep, and their total length of sleep was shorter than that of children who went to sleep earlier.[2]

Lydia Roberts gives the following table of sleep requirement based on her observations of nursery-school children and older children which is also somewhat less than that stipulated by most authors.[3]

[1] *Public Health News*, Alameda County, California, December, 1928.

[2] White, Margaret Richie, Some Factors Affecting the Night Sleep of Children, *Child Development*, September, 1930.

[3] Roberts, Lydia J., *Nutrition Work with Children*, p. 115, reprinted by permission of University of Chicago Press, 1927.

THE MINIMUM SLEEP REQUIREMENTS OF NORMAL CHILDREN

Age	Hours of sleep not less than	Bedtime not later than
2 and 3	12½	6:30
4 and 5	12	7:00
6 and 7	11½	7:00
8 and 9	11	8:00
10 and 11	10½	8:00
12 and 13	10	8:30
All through the growing period	9	9:00

It is generally conceded that "sleeping round the clock" is a valuable habit which should be continued as nearly as possible throughout the growing years. To this should be added naps to make up the gradually diminishing sleep quotient of the child. The two naps will become short in duration and finally, between two and three years of age or earlier, should be merged into one. When the child goes on a definite four-meal schedule the logical time for the nap will be right after the second meal, which will probably be about 11 A. M. He "sleeps his sleep out," and will be ready to go to bed again at 6 P. M. If the day is not broken evenly by the nap the child will become too tired during the long morning and may be too nervous and irritable to go readily to sleep; then he will sleep late in the afternoon and will object to going to bed at the usual time and be unable to sleep if he is forced to go.

Too often mothers interpret inability to go to sleep as an indication that the child needs less sleep when it may be really an indication of overfatigue and nervous excitement. Certainly every child should sleep all he can sleep, and conditions should be made favorable for regular and maximum hours of sleep.

Time Required to Go to Sleep.—Some of the present confusion as to total hours of sleep is doubtless due to failure to deduct the time spent in going to sleep from the time spent in bed. It is a matter of surprise to discover that it takes even young children, or perhaps we should say, especially young children, a long time to go to sleep. The report of one investigation using 100 subjects states that it takes children 2½ to 4 years of age an average of 36 minutes to get to sleep. College men, 13 minutes;

middle-aged men, 15 minutes; the wives of middle-aged men, 13 minutes.

School Life and Sleep.—It is desirable that the child be "weaned from his nap" and that he be running smoothly on a long unbroken night schedule before he starts to school. Kindergartens should either return the child who has not been so prepared to his home in time for his nap or else provide accommodations for midsession naps for children who still require daytime sleep.

The adjustments to school life are drastic enough if there is as little disturbance of the child's regular regimen as possible. It will take careful management to prevent the child from losing sleep when he first starts to school because of the excitement of his excursion into a new life. He may be a long time going to sleep, but he must be awakened in the morning and "gotten off to school." A sleepy, tired child does not eat well and may come back irritable and fatigued and negativistic, and a situation is created which may react upon the happiness and health of the child for years if it is not recognized and skillfully handled.

The Hygiene of Sleep.—Conditions must be favorable for sleep to the extent that the child is made comfortable, the house free from new and unusual noises, and the child's mind quiet and tranquil.

Comfort means a bed large enough to permit the child to stretch out freely in any position he pleases, a mattress that does not sag, and light, warm covering so arranged that it does not restrict freedom of movement (see page 286). Fresh air should be the rule both night and day.

Noise.—Children should be conditioned from the first to ignore the noises occasioned by the regular household machinery. New or unusually loud or sudden or harsh noises should be avoided if possible. It is a mistake to restrict the necessary activities of the family during the child's sleep except temporarily in case of illness.

Mental Quiet.—A wide-awake, excited brain cannot stop functioning abruptly. Exciting play, exciting stories, disciplinary conflict should be avoided in the late afternoon and evening. Quiet happy stories, especially the monotonous repetition of favorites, quiet happy conversation, or recitation of rhythmic

poems will prepare the child's mind for sleep. Some parents believe it is better to accustom the child from the earliest establishment of habits to go to bed at the stroke of the clock and have the light turned out and be left alone as a matter of course. Both methods have their points. On the one hand, the bedtime hour may be the father's only opportunity to establish friendly contact, and the memory of the bedtime hour may be one of the child's life treasures. On the other hand, the child may be inclined, as he grows older, to prolong the delights of the situation, demand the light, drinks, more stories, and exploit the over-indulgent parent. From the reported observations as to the time it takes a child to go to sleep it would seem that the psychology of this drowsing off is important. The infant should become pleasantly accustomed to darkness and the older child to enjoying his own thoughts.

In any event, the child should go to bed happy and at peace with the world. This is not accomplished by indulgence, as the indulged child is never tranquil or happy. The happy child is the one who is well fed, healthily tired, and as free from worry as a puppy, and one who accepts the established routines of his life because he has never discovered that things could be different.

Sleeping in the Dark.—Fear of the dark is an acquired and not an instinctive fear. Like all other difficulties of childhood, it is more easily prevented than corrected. Many children demand the light because they share the room with adults who commonly have the room lighted after the child has gone to bed. If a light is necessary at night, a very dim night light should be used, and a strong light should never be turned on the sleeping child's face. Neither should he be expected to go to sleep in a light room, for that is unnatural and tends to prevent deep and restful sleep. The psychology of fear of the dark is discussed on page 505.

Urinating at Night.—Children should be trained to get up regularly during the night to void urine. Few children can safely and comfortably go 12 hours without emptying the bladder. Some older children will do this, but it usually involves too much distention of the bladder and pressure upon other pelvic and abdominal organs. The other alternatives are wetting the bed, which is one of the most distressing and difficult and unnecessary

problems of childhood; or waking early in the morning because of discomfort and finding it impossible to go to sleep again. This is most apt to occur with the high-strung child who most needs the sleep. Training the child at night involves training the parent during the first few years, but the habit of awaking regularly to conduct the child to the toilet becomes automatic and almost unconscious, and the child who is thus trained comes to take care of himself often by the age of four or five and will make the trip without fully waking.

Other Conditions.—The child who has a cold should have the nasal passages thoroughly cleaned with oil at bedtime and when he urinates in the night. This will help him to secure the restful sleep he especially needs to resist the infection.

No child should go to bed with the bowel loaded with fecal matter. If the bowels have for some reason not moved at the usual time, a small soapsuds, a normal salt solution, or an oil enema should be given before bedtime to minimize the absorption of toxins and to protect the nervous system from reflex irritations.

Sleep in cool or cold air is most refreshing because it is more stimulating to respiration and circulation. In the Minnesota investigation it was found that the children slept best in a temperature of 55° to 58°.

It is needless to say that young children should never be taken to movies or permitted to stay up past the bedtime hour because of company or other special occasion in the home. It takes heroic courage to avoid this sometimes, but it saves much trouble in the end, both physical trouble for the child and disciplinary trouble for the parent.

"Tired Nature's sweet restorer, Balmy Sleep," is the friend of childhood.

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CHAPTER XXI

THE HYGIENE OF CHILDHOOD: POSTURE

The young child, Christ, is straight and wise
And asks questions of the old men, questions
Found under running water for all children,
And found under shadows thrown on still waters
By tall trees looking downward, old and gnarled,
Found to the eyes of children alone, untold,
Singing a low song in the loneliness.
And the young child, Christ, goes on asking
And the old men answer nothing and only know love
For the young child, Christ, straight and wise.

CARL SANDBURG.[1]

The Meaning of Posture.—It is interesting to consider how evolution has lifted life from the surface of the earth. It almost seems as if life were reaching out into interstellar space. First, life floated in the sea, then crept upon the land, climbed into trees, made brief excursions through the air, but always gravity has pulled it back and the earth has hugged its own with jealous force.

While the primates have succeeded in briefly defying gravity by maintaining an upright position, man is the first animal to acquire and habitually maintain (except during his sleep) a posture in opposition to the laws of gravitation. Not only so, but defiance of gravitation is one of the signs of health. The more vigorous one feels the taller he stands, the more he has a feeling of "spurning the earth"; conversely, when one is wearied or depressed he droops.

The healthy, joyous child leaps and dances and goes on tiptoe. The dance itself doubtless had its origin in the need to express mental and physical exhilaration in defiance of the earthly pull, a rising on the toes, a reaching out of the arms, a turning of the face toward the sky. Indeed, it is possible that the feminine fashion of wearing high heels and pointed-toed shoes is an uncon-

[1] "Child," from *Chicago Poems*, Henry Holt & Company.

scious expression of this instinctive desire to spurn the earth. Posture is a definite index of well-being or the reverse, but it is more than a physical index, it is also a spiritual and emotional index.

Good Posture.—It is an incredibly complex and delicate mechanical achievement when the baby first hoists his body into a vertical position and balances himself upon his tiny feet. Every one of the complicated muscle-bone levers in his body is thrown into new tensions. There must be precise adjustment of flexors and extensors if the center of gravity is to be maintained with a minimum of effort and of energy expenditure. Floyd A. Rowe defines good posture as "A winning fight of the human mechanism and will power against the pull of gravity."[1] *Correct posture is a position of such perfect balance that every organ and part of the body has maximum freedom and that there is an even distribution of strain and a minimum tension upon the muscles.*

Good posture depends upon several basic factors:

1. Good bone. The rachitic, undernourished child cannot maintain good posture because the pull of the muscles bends and distorts the soft bones, which have not been able to take up the normal amount of minerals from the blood stream.

2. Good muscle. The undernourished child will have "loose joints," "winged" scapulae, a "fatigue posture," and a very characteristic general slackness of ligaments and muscles.

3. Good alignment. A child may have normal bone and muscle structure and still be prevented from acquiring good posture because of restrictions upon his free activity from clothing, cribs, and walkers, and from lack of opportunity to use all parts of his body. The change from all fours to upright posture involves radical changes in leverage which can only be accomplished by active development and stretching and adjustment of hip, back, leg, shoulder, chest, and abdominal muscles.

The Big Muscles.—The large levers of leg and arm are matured first and used first. The child and the primate use only "big muscles." They run, climb, throw, and jump. It is later in life and in civilization that fine coordinations and fine reflexes appear, making drawing, writing, and craft work possible. The

[1] Rowe, Floyd A., in *The Nation's Health*, January, 1922.

child must climb his racial tree (see page 30) in this respect as in every other if he is to have sound basic growth.

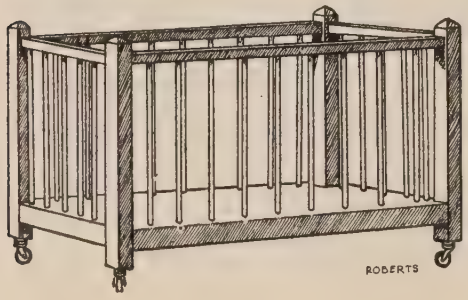
Acquiring Good Posture.—Good posture may be said to depend upon "food and freedom." The child must have proper food and care in order to secure good bone and muscle. This has been fully discussed in the previous chapters. *He must also have freedom of movement.* The normal infant or young child is ceaselessly active during every waking moment and is even active during sleep (see page 352). Exercise is the law of life. Living matter which cannot exercise its innate functions deteriorates and ultimately dies. One of the things that makes an organism an organism is that there is bound up in its structure an urge to exercise every part of that structure according to the necessities of the best development and growth of the whole (see page 487). It cannot be overemphasized that *the infant should have absolute freedom for the exercise of developmental urge in every part of his body.* It is being advised by child health specialists that the infant be permitted to kick and play for a few minutes while undressed for his bath in the morning and again when changing to his night clothes in the evening. This exposure of the skin to the air is a good thing and the entire absence of clothing a delightful incentive to exercise. However, he should not be restricted in the free movement of every part of his body at any time, by his clothing, covers, buggy strap, or anything else.

An infant who works out his body constantly and continuously according to his organic muscle urge will prepare himself to sit and stand and walk, and will have instinctively trained and developed the necessary muscles. The infant who is not hampered will do a "daily dozen" which will put any system of artificial exercises to blush in their rhythmic beauty and completeness. "Systems of exercise" which are sometimes advised for infants are at best clumsy and bungling and are incomplete imitations of the normal child's own natural procedures. All he wants is a chance! Not for a few minutes of freedom now and then when the mother happens to think about it or finds it convenient, but a constant opportunity to exercise at his own convenience and inclination.

This freedom to exercise every part of his body freely at all times should continue throughout his growing years. As soon

as the child sits alone with assurance he should spend his waking hours in a play pen. Here he can sit, or lie, or roll over and creep, or pull himself up, at his pleasure, without waiting for the accidental and occasional and entirely unenlightened assistance of his elders.

Body Control.—When he wants to reach up and climb he should be encouraged to do so, and a clean, safe place provided where



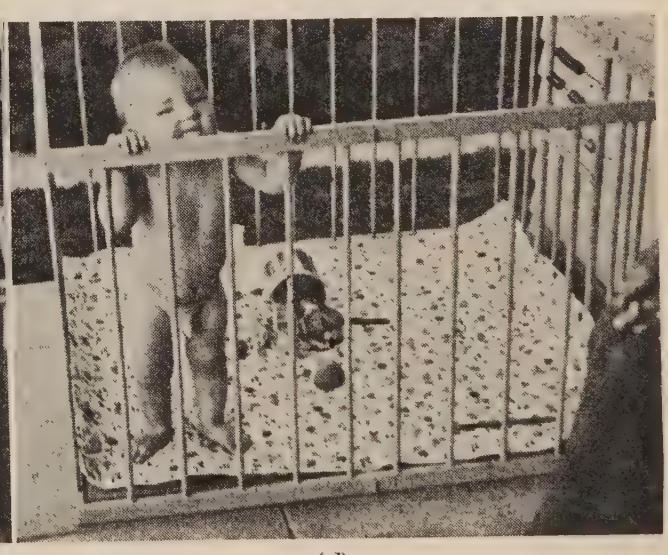
(*a*)



(*b*)



(*c*)



(*d*)

FIG. 67.—Play pens. (*a*) Indoor pen; (*b*) stationary outdoor pen. (*Courtesy Kansas State Board of Health*); (*c*) movable outdoor pen, hinged and collapsible; (*d*) child pulls himself up and teaches himself to walk.

he may go up and down two or three steps *until he masters both techniques.* Infants will climb steps before they can walk, and it is a fine coordinating exercise for giving the child command of himself. This is an excellent opportunity for putting one of the fundamental precepts of child training into execution, *viz.*, "Every experience should be a complete experience" (see page 508). The first time a child climbs steps he should also come down, no matter how inconvenient or time-consuming it may be for the mother to accomplish this. Moreover, *the child*

should come back every time he goes up. In this way he acquires mental and physical discipline in ability to think for himself and care for himself.[1]



FIG. 68.—He who goes up—must come down.

To snatch the child out of any place he has gotten himself into and to try to "condition" him for safety by scaring or punishing



FIG. 69.—A complete experience.

Going up. Farther up Coming down.

him is poor psychology and poor training and the child has a perfect right to howl because he has been baffled in a legitimate

[1] GESELL, ARNOLD, Physical Education in the Preschool Years, *American Physical Education Review*, November, 1929; GESELL, ARNOLD, Some Relations between Early Physical and Mental Growth, *Mind-body Relationships*, A. S. Barnes & Co., 1931.

and instinctively correct impulse to conquer his environment and try out his body machinery. He can get himself out of almost any place he can get into, and he should at least make the effort and connect the two ideas from his very first explorations into the unknown world about him. To restrict a child's activity "for fear he will hurt himself" stores up trouble for parent and child and limits his mental and physical development (see page 509).



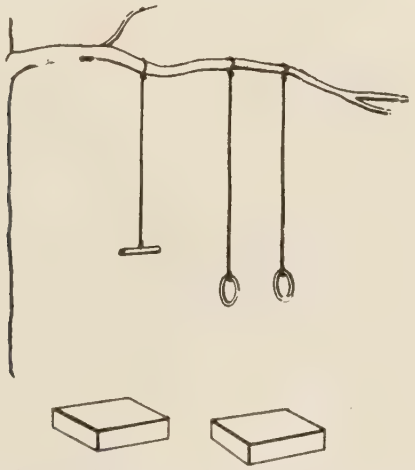
Fig. 70.—Jumpers may distort the body. Note how the child's legs are forced apart and his back rounded.

Balanced Exercise.—From the time the child walks he will need a great variety of safe opportunities to use all parts of his body. According to the usual household organization there is plenty of encouragement to use the legs. Oftentimes there is over-encouragement with walkers, jumpers, kiddy-cars, tricycles, etc., but *almost no opportunity for, and more or less discouragement in the use of arm, back, and shoulder muscles.*

The infant normally and usually creeps before he walks. In doing this he pushes back his shoulders, flattens his shoulder blades (scapulae) and exercises the entire shoulder girdle. He next pulls himself up by chairs or crib side and continues the use of the shoulder girdle. If let alone he will climb everything climbable and will never stop using and developing chest, back, abdominal, and arm muscles. Wise parents will see to it that he has plenty of safe opportunity to do this. The nursery ladder, the nursery steps, a variety of boxes, etc., will provide such exercise with a minimum expense. As the child grows older little hand-bar swings, flying rings, doorway gyms, etc., may be added. Some of these devices are illustrated in Fig. 71.

Clothing and Posture.—When we remember how undeveloped the muscles of the child's body are, and how new leverages must

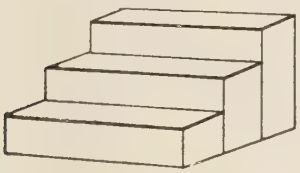
be established when the child stands up, it will be clear that these difficulties should not be increased by restrictive clothing. The present way of clothing the human body presents certain serious



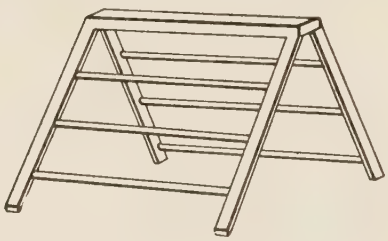
Two types of hand swings which strengthen back and arms and chest. The child must stand on box to reach handles so his body will swing free.



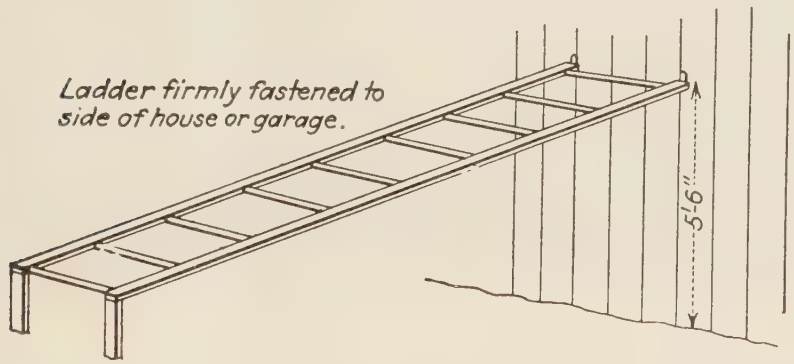
Indoor ladder for child from 10 months to 5 years



Practice steps for the creeping and toddling child.



Another type of climbing ladder which young children enjoy and find many uses for.



A common ladder makes a splendid piece of apparatus for developing all parts of the child's body. May be used from two or three years on.

FIG. 71.—Homemade play equipment which develops the entire body.

difficulties of adjustment. Practically all types of clothing for all ages and sexes involve separate pieces of covering for the trunk, the thighs, and the feet and legs. These three segments of

clothing must somehow be held together against the pull of gravity. There seem to be two possible ways of doing this: (1) to suspend the clothing from the shoulder, or (2) to use belts and garters of sufficient tightness to withstand the force of gravity. Suspending clothing from the shoulders is the prefer-



FIG. 72.—Homemade slides and ladders find many uses.

able method, but must be done with great care in the case of the child, or the pull will come upon the tip of the shoulder and will cause the shoulder blade to spring out, producing the very common postural defect known as "angel wings." This, by narrowing the chest, makes it impossible to fill the apices of the lungs with air. Any type of garment may have this effect if not properly fitted. The most vicious example is found in the

very prevalent commercial "waist" with an array of buttons about the waist line to which skirts, drawers, and supporters are attached. Directly under, or worse, in front of, the arm will be found the stocking supporter. In order to keep stockings from



FIG. 73.—Homemade slides and ladders.

wrinkling down as the child jumps and runs, especially if the stockings are as easy-fitting as they should be, the elastic must be snugly adjusted. This brings a constant pull upon the loosely adjusted shoulder girdle of the child. Rounding his shoulders makes it necessary for him to throw out his abdomen in order to maintain his balance on his feet. The rachitic and undernourished child, of course, shows the most marked and lasting

deformities. By careful adjustment of the cloth or skeleton waist the pull of the garter can be shifted from the tip of the shoulder to the broad neck muscles. Even then the active child is apt to displace this.

The wearing of round garters if only *barely* tight enough to keep up short stockings is comparatively unobjectionable. With long stockings, however, round garters above the knees must be tight enough to impede circulation or they will not stay in place on the normally plump and tapering leg. Leaving knees bare in winter is merely a fad with no justification on the ground of reason or beauty. A vigorous child will condition himself to almost anything which occurs with regularity in his experience and could become used to going without any clothing for that matter, but it is difficult to see anything to commend the practice to common use, and children with low resistance may even be injured. Bloomer bands or elastics should never be tight enough to leave a mark on the skin. Keeping the fashionable long trousers in place on the active waistless boy by means of a belt is a striking example of the irrational lengths to which customs will lead. The gratitude of the whole child world awaits the person who invents a style of dress for children to wear in cold weather which will clothe them evenly, adequately, beautifully, and do this without distorting the body. At the present time, when houses are warmly and evenly heated as a rule, it is good practice to dress the preschool child exactly the same in winter as in summer when indoors. On going out



FIG. 74.—Wrong type of stocking supporter. Note how the pull upon the shoulder distorts the scapula (shoulder blade).

one-piece coveralls with zipper fastenings provide even protection for the entire body, and do not restrict movement.

Feet, Shoes, and Posture.—The human animal needs a large foot surface to support his difficult upright posture. A relatively large surface of support should be considered to be a mark of beauty and efficiency. Fortunately, there is no tendency in America to cramp the foot of the growing child. Children's shoes are not always well shaped, however. The delicate mechanism



FIG. 75.—The foot at different ages. Note the gradual development of the lateral and transverse arches.

of the foot should be carefully safeguarded, and every parent should watch this continuously from the first steps or, rather, the first stocking, until adulthood.

The natural foot spreads in order to furnish support in walking. In a way, the heel is the equivalent of the hind legs of the quadruped, the ball of the foot the equivalent of the front legs. In walking the weight rhythmically shifts from heel to ball. The long arch is the buggy spring or shock absorber which breaks the jar and protects the nervous system, especially the spinal cord, from a measure of the forceful impact with the ground. Flat-footed people tire quickly in standing or walking.

Under the ball of the foot is a small transverse or "anterior" arch which acts as a spring or shock absorber when the weight shifts from the heel to the toe. Only the pads under the ball of the foot just behind the great and small toes should touch the ground in the adult foot. The blood and nerve supplies of the foot are protected by the arches. When the anterior arch is flattened by bad shoes, walking becomes painful because of pres-

sure upon these nerves. Whereas the four-footed animal has no use for shock absorbers or springs, we find these called into being by use. The infant and toddler have a primitive foot with no arches. The foot is entirely in contact with the floor until thirty to thirty-six months of age. This is partly due to the early cushion of fat, which tends to disappear. The child, through use in walking, jumping, etc., should develop both long and transverse arches; but shoes which give perfect freedom to the entire mechanism, especially to the ankle and the long arch, are necessary. Children should go barefooted as much as possible and should wear only shoes with perfectly flexible shanks.

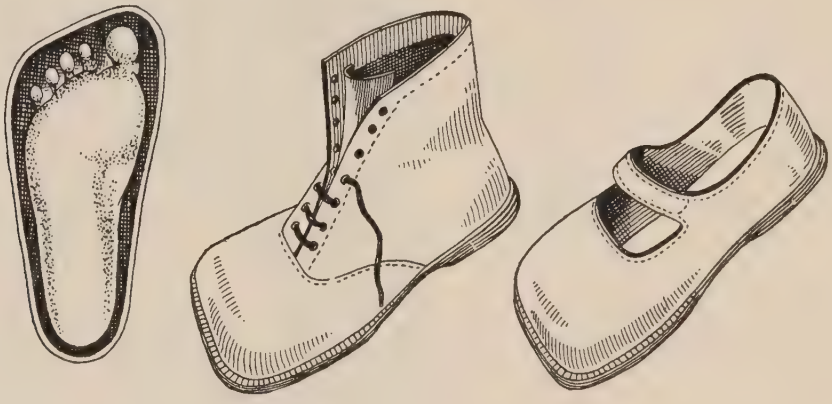


Fig. 76.—Proper shoes.

The great toe is the chief remnant of the prehensile or gripping structure of the primitive foot. If permitted to function, it still serves a very useful purpose in gripping the ground and steadying the body in its walking progress. Fatigue is minimized and good posture assisted if the individual can have the service of his great toe. The two points of importance, then, in the hygiene of the young child's foot are: (1) protect the great toe, and (2) protect the development and use of the arches.

The great toe is frequently bent and deformed before the child even stands upon his feet by having his soft little foot crowded into a stocking which he has outgrown or which has shrunk in washing. After he gets upon his feet the mother should watch carefully that he does not outgrow the inner line of his shoe and begin to bend the toe, and also that his stockings do not become too short. *Short stockings may do as much harm as short shoes.* Shoes should be flexible, with long straight inner line and broad toe, and the soles should project far enough to protect the foot,

but not far enough to be in the way. "We spend all our lives in our shoes or in our beds." Both become important, especially to the young child.[1]

In most modern houses which are kept at a fairly uniform winter temperature of 70° or more, it would probably be highly beneficial if toddling children habitually went barefooted and wore the same one-piece garment they now wear in the summer. This would make for better structural development, better body

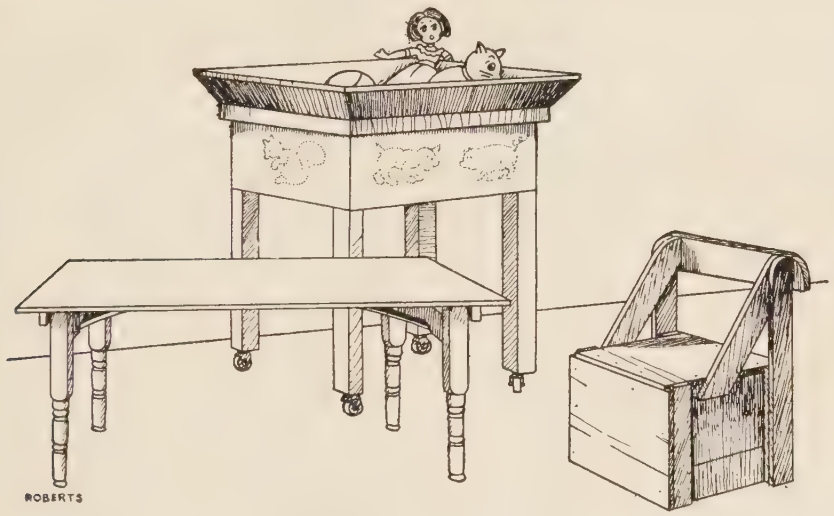


FIG. 77.—Homemade chair; shortened sewing table; homemade sand box. (*Department of Home Economics, University of Kansas.*)

mechanics, and also for better circulation and better functioning of the skin.

Furniture and Posture.—The child is commonly ignored in planning and furnishing the home, and in many homes the child has no choice between the floor and adult chairs and tables. The result is that he crouches continually over his playthings. It is important that he should have a chair and a play table which are as carefully adjusted to his size as are the chair and table of the adult. Since he will need several sizes of these as he grows, both chair and table may be made from boxes, or a table may be made by sawing off the legs of a used table, and the cost thus reduced to a minimum (see Fig. 77).

Good posture is essential to free and efficient activity and development of strength. It is essential to the health and proper

[1] SWEET, WATSON, and STAFFORD, Physiological Changes in Posture during the First Six Years of Life, *Journal of the American Medical Association*, Nov. 17, 1928.

function of the lungs, the heart, the stomach, the bowels, and the pelvic organs. To obtain a strong, well-developed, well-aligned body for the child becomes one of the earliest and most constant duties of the watchful parent.

Body Mechanics.[1]—The Subcommittee on Orthopedics and Body Mechanics of the White House Conference on Child Health and Protection of 1930 recommends that the term *body mechanics*

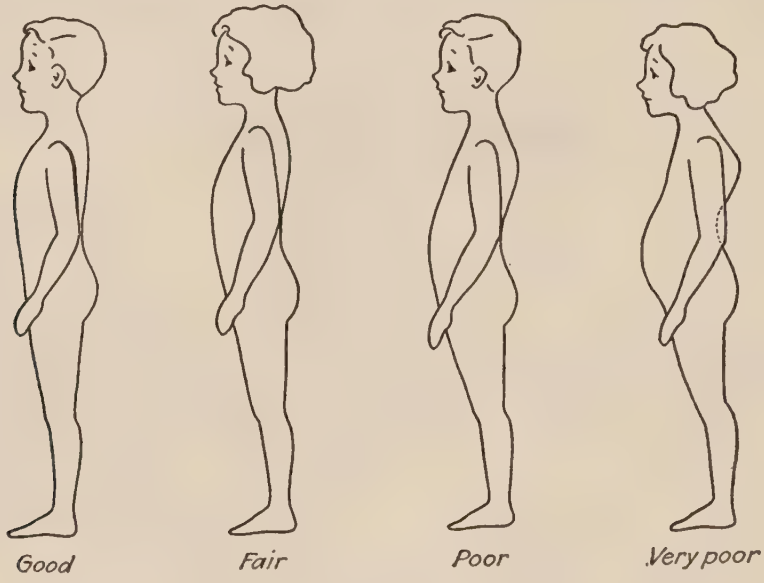


FIG. 78.—Types of posture.

be employed wherever possible instead of the term *posture* as being more inclusive and descriptive.

Body mechanics may be defined as the mechanical correlation of the various systems of the body with special reference to the skeletal, muscular, and visceral systems and their neurological associations. Normal body mechanics may be said to obtain when this mechancial correlation is most favorable to the function of these systems.

An exhaustive analysis is given of the factors of posture and associated defects. A report is given of all available studies of the incidence of poor posture among groups of various ages, and the conclusion is drawn that "perhaps 75 per cent of the male and female youth of the United States exhibit grades of body mechanics which, according to the standards of this Subcommittee, are imperfect."

[1] *Body Mechanics: Education and Practice*, Report of the Subcommittee on Orthopedics and Body Mechanics of the White House Conference, D. Appleton-Century Company, 1932.

The association of good body mechanics with good health and of poor body mechanics with poor health is a difficult matter to determine, since good health depends upon so many factors. There is considerable experimental evidence, however, that good body mechanics and good health have a definite correlation.

The Subcommittee believes that there is evidence to show that good body mechanics and good functional health in children go hand in hand and that poor body mechanics and poor functional health are commonly associated. It believes that there is evidence to suggest strongly that good body mechanics may bear a causal relation to good functional health and poor body mechanics may bear a causal relation to poor functional health.

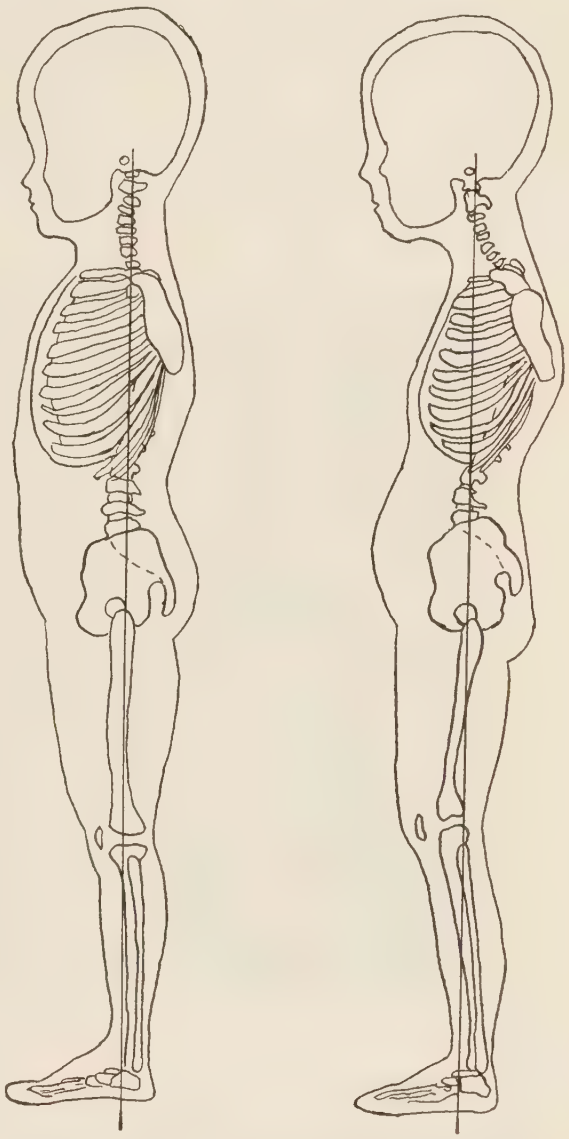


FIG. 79.—The mechanics of good and poor posture. (*From The Child from One to Six, Federal Children's Bureau.*)

Correction of Postural (Mechanical) Defects.—The first thing to do in correcting defects of bodily adjustment is to remove causes. If poor nutrition is a factor, the child's general condition must be brought up to par. The child's clothing must be scrutinized, also his environment: his bed, chairs, etc.

The second step is the provision of interesting incentives to stretch the body, to swing by the arms, to climb, to run, to throw, in short, to use the "big muscles." Most children will correct their own defects when the factors causing them are removed. If in the course of weeks or months continuous improvement is not noted, more intensive measures may be necessary.

The third step is the employment of corrective measures. The advice of an orthopedic specialist should *always* be obtained in the case of pathological changes from infantile paralysis, injuries, etc. Where the mechanical defects are merely the result of faulty habits or faulty environment, corrective exercises may be used advantageously. It must be remembered, however, that *first and always the child should be happy,* and efforts at correction must not become irksome or coercive. It is of no use to say to the toddler "straighten up, you want a nice, straight



FIG. 80.—Encourage the development of the "top of the body."

back, don't you?" He is not developmentally ready (see chap. XXVIII) to understand this. He will enter joyfully, however, into playing "duck," "giraffe," and other corrective games. He should, if possible, not know the purpose of these, and should be protected from the idea that he is different from or inferior to other children.

In *The Preschool Child and His Posture,* delightful posture games are pictured and described.[1] The important items are, however, nutrition and freedom; and the resultant happy, vigorous activity will do wonders in straightening and aligning even marked distortions and deviations from symmetry.

[1] RICHARDSON and HEARN, *The Preschool Child and His Posture,* G. P. Putnam's Sons, 1930.

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CHAPTER XXII

THE HYGIENE OF THE HEAD

The First Tooth
(Sister's Lament)

Through the house what busy joy,
Just because the infant boy
Has a tiny tooth to show.
I have got a double row,
All as white, and all as small;
Yet no one cares for mine at all.
He can say but half a word,
Yet that single sound's preferred
To all the words that I can say
In the longest summer day.
He cannot walk, yet if he put
With mimic motion out his foot,
As if he thought he were advancing,
It's prized more than my best dancing.

MARY LAMB.[1]

Teething and the Teeth.—The growth of the teeth is a continuous process from seven months before the child is born until the wisdom teeth reach full size. It is only when the teeth "cut through" the gums that we become aware of the development of the teeth. Except for the slight soreness which accompanies the pushing through the tougher outer layer of the gum, the process of "teething" which we see is no different from the process going on all the time which we do not see.

Teething should never make a child sick, although it may make him fretful and irritable, and he may not eat so well because his gums hurt. Since the teeth appear during a period when the child is changing his diet and is especially liable to digestive troubles, a superstitious notion has prevailed that the teeth were to blame for most of the illness the baby incurs during this period. This leads to neglect of many serious conditions. A healthy child who is properly fed and cared for will seldom know

[1] From *The Works of Charles and Mary Lamb,* Vol. III, Books for Children. By permission of The Macmillan Company, publishers.

when his teeth come through or show any indisposition. Once in a long time a child may have abnormally difficult eruption of its teeth and suffer considerable pain. Special care should be taken in the feeding of such a child. It should be fed easily digestible food, and given all the water it will drink, and taken to a doctor.

Time of Eruption.—The first teeth to show are usually the 2 central cutting teeth, or incisors, on the lower jaw, which appear between the fourth and sixth months. The 2 central upper incisors may come next between eight and twelve months. The 2 other cutting teeth on the lower jaw will usually come next, making 8 cutting teeth (incisors) by the end of the first year. The first grinding teeth, or molars, come between twelve and fifteen months, one on each side, above and below. The "eye-teeth," or upper canines, and the "stomach teeth," or lower canines, appear between eighteen and twenty-four months. These come in at the "corners" or angles of the jaw, between the incisors and the molars. The second 4 grinders, or molars, appear between twenty-four and thirty months, making 20 temporary or "milk teeth" by the time the baby is two and a half years old.

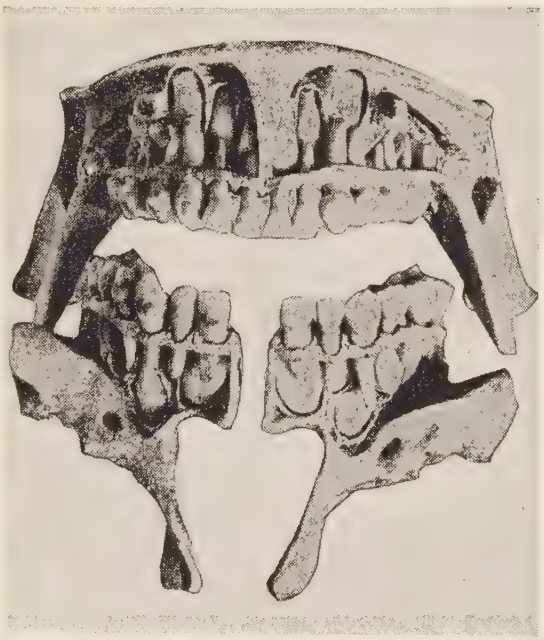


FIG. 81.—Jaws of a six-year-old child showing the permanent teeth developing behind the temporary teeth. (*From Morris, Human Anatomy, P. Blakiston's Son & Co.*)

The first permanent teeth are the third set of 4 grinders, commonly called the "six-year molars," which come through between the fifth and sixth years. It is very important that the first permanent teeth should not decay. The shape of the jaw will be changed and the upper and lower teeth will never fit together correctly if any of these teeth are lost. Many parents do not know that these are permanent teeth and fail to appreciate their importance to the child.

The next quartet of permanent molars comes through at about twelve, and the last set, the "wisdom teeth," begin to erupt at about eighteen, making 32 permanent teeth. The child commonly loses all of his milk teeth between the ages of six and twelve years.

Diet and the Teeth.—The pregnant woman who does not eat enough bone-forming food or receive sufficient vitamins and sunlight is robbing her unborn babe of good teeth. Many

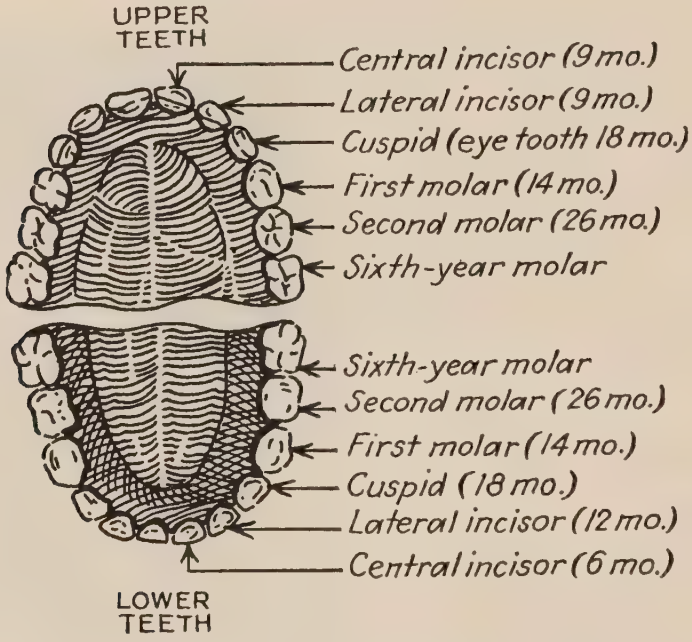


FIG. 82.—The temporary teeth with order of eruption; also the first permanent teeth, the "six-year-molars."

children have poor, soft teeth for this reason; also for the reason that such a mother cannot make good, bone-forming milk for her babe after it is born. Bone-forming diet is important for both mother and child. All the "care" in the world cannot save poor teeth or make good teeth out of poor ones. Fresh milk, whole-grain cereals, and plenty of fresh fruits and vegetables are necessary to good teeth. As we have seen in discussing rickets, vitamin D is essential to the utilization of bone-forming food. It has lately been shown that vitamin C, the antiscorbutic vitamin, is of great importance in the growth and preservation of the dental structures, especially in the matter of immunity to dental and gum infections. This is, of course, additional reason for liberal use of orange and tomato juice in the early diet

of the child.[1] In short, the *balanced diet* is essential to growth and health of the teeth, as is true of all other body structures.

Using the Teeth.—The baby should use his first teeth on their earliest appearance upon a hard crust or very hard cracker. Every day from that time on he should be given something upon which to practice chewing. *All through a child's growing years he should be encouraged to chew,* for chewing separates and spaces the teeth properly in the jaw, toughens the gums, stimulates circulation and development, and also aids in digestion.

Care of the Teeth.—From the time the milk teeth are all showing the child should be provided with a child's soft toothbrush and shown daily how to brush up and down, inside and out. This is the imitative age, and habits formed during these years last through life.

It is not necessary to use anything on the brush, as the natural fluids of the mouth are sufficiently cleansing, provided the teeth are mechanically cleaned and food is not left to decay between them. Children will enjoy the procedure more, however, if a little salt is placed on the brush, and this also tends to toughen the gums. There is no objection, however, to the use of good unsweetened tooth pastes and powders.

The soft brush should be replaced by slightly stiffer brushes as the child grows older. The parent should never neglect to see that the child has a good brush, frequently renewed, and that he takes care of it and uses it daily. A dirty toothbrush is much worse than none, since infective germs adhere to it and multiply in enormous numbers. Indeed, there seems to be a growing feeling that the toothbrush *as ordinarily used* may not afford the protection we have imagined.[2]

[1] Hanke and Sprague, Rôle of Diet in the Cause, Prevention, and Cure of Dental Disease, *Journal of Nutrition*, January, 1931.

[2] Dr. Osborn describes a substitute for the bristle brush called "Re Vira" which consists of compressed pledgets of cotton which are inserted in a holder; each pledget used once and thrown away. A brush that is too stiff may leave small abrasions in the gums in which germs readily grow. The same may be said of the use of toothpicks and dental floss. In Dr. Osborn's opinion, thorough rinsing of the mouth after eating is better (Oliver T. Osborn, *What Every One Should Know*, p. 16, Charles Thomas Publishing Company, 1929).

Dentistry.—If the child is healthy and the teeth are never neglected from infancy onward, stain and tartar will not be likely to collect on them. If the teeth should collect stain which will not brush off, the mother may take burnt matches and try to scour it off, applying the charred end to each tooth in succession as daintily and thoroughly as if scouring a piece of jewelry. If she is still unsuccessful the child should be taken at once to a dentist to have the teeth cleaned and polished, because such deposits hold and harbor germs and start spots of decay. Whenever the smallest cavity appears it should be filled at once. A soft filling will stop the decay; it will not hurt to have it filled, and it may save ill health, suffering, and money.

A mother should never go a second time to a dentist who says, "It is not worth while to fill milk teeth; they soon come out anyway." She should go at once to a more up-to-date man who appreciates the importance of good teeth for growing children. Modern dentists are keenly alive to the importance of the care of the teeth in pregnancy and infancy, and especially of the rôle of diet. The family dentist should be as much an "institution" as the family doctor. He should be paid to look after the teeth of all the members of the family regularly, calling them in at necessary intervals for this attention.[1]

The second teeth will seldom be better than the first teeth. It is now known that many of the serious diseases of later life are caused by neglect of teeth not only in later life but also in infancy. No parent who realizes this will permit a child's teeth to decay.

The Nose and the Sinuses.—*The nose* is the organ of air control. It is more complex and more important than is commonly understood. The hygiene of the nose is especially important in a climate which exposes its mechanism to extremes of temperature, humidity, and dust content. It is important that the child should have and keep a normal air-organ, since disease and impairment of the nose in childhood may persist in various chronic derangements.

[1] Preventive Dentistry, pp. 189–191, *American Journal of Public Health*, June, 1931.

The nose projects from the face in such a way that air from a wide angle is drawn into its passages. It is interesting to note the two nostrils, and reflect how often we are glad we have two when one is injured or obstructed, leaving us the service of the other one.

The septum or partition between the nostrils (nares) is sometimes incompletely developed and sometimes becomes bent or displaced by a fall or blow. It is important to have this condition corrected, since the interference with the circulation and the pressure upon nerves may cause pain and obscure headache and also create a condition favorable to the development of infection.

Projecting from the external walls of the nostrils are three shelf-like structures called *turbinates* (see Fig. 27). These are cleverly arranged for the purpose of creating a maximum surface of exposure to the inspired air and of slowing down the passage of air through the nose, giving it time to become warm, moist, and clean. The entrance to the turbinate passages is guarded by coarse hairs which strain out larger particles of foreign matter from the air.

Opposite the posterior openings of the nares, on the back of the naso-pharynx or upper part of the throat, is found the adenoid mass described on page 386, against which the air strikes as it is forcibly drawn through the narrow turbinate passages.

The turbinates and nasal walls are covered with a ciliated mucous membrane, under which lie many secretory glands which keep the surface moist at all times in health. When irritated by chemicals, bacteria, heat, or cold these glands can, on occasion, such as when pepper is inhaled, or during an acute cold, pour forth copious amounts of fluid secretion. Normally the nasal secretion is small in amount, highly viscid, and mildly antiseptic. The cilia of the membrane are always in motion, waving toward the exterior like a wheat field in the wind, thus bringing dust and irritants out of the interior of the cavity to be expelled in the nasal secretions.

The blood supply to the membrane is generous. It is found in part in a spongy erectile tissue which becomes congested quickly, thus closing off the narrow passages between the turbinates. This reaction is doubtless protective in shutting off the

entrance of air which is injurious, such as very cold air or air containing irritant gases, or during acute "cold" infection, or air containing the pollen proteins which cause hay fever.[1]

It will be seen that air when inhaled is strained, washed, warmed, sterilized, and moistened during the instant in which it is being drawn through the nares. The individual who must draw his air through his mouth has none of this protection. By actual experiment, the air which leaves the nose to pass into the lungs is shown to have had an incredible number of bacteria destroyed as compared with the air as it entered the nose.

The hygiene of the nose is chiefly the hygiene of ventilation. Of all the possible faults of ventilation, dryness with heat is perhaps the most injurious to the nasal structures. The dryness of freezing air is stimulating, increasing the flow of secretion in order that the inhaled air may be brought near to the body temperature before entering the lungs. The dryness of hot air, however, debilitates these protective mechanisms, small abrasions or cracks occur, and the entrance of the great variety of respiratory infections is invited. *It is very important that the young child shall breathe only cool, moist, moving air.* This air should be free from dust and disease germs.

The sinuses are hollow places in the skull and its parts, which are connected with the nasal cavity by tubular passages. The principal sinuses are those over the eyes (frontal sinus); in the cheek bone (the antrum); and in the middle ear (via the eustachian tube). Infection may pass from the middle ear into the mastoid cavities behind the ear. Infection may also reach ethmoid and sphenoid cells behind the nose; and traverse the tear ducts which carry secretions from the corners of the eyes to the nose. Infected secretions may be readily forced from the nose to these various parts in the small child, as these passages are relatively larger and more direct than in the adult.

Care of the Nose.—In a state of health the infant's or child's nose should be left alone. The natural secretions will keep it in a sanitary, clean condition. When the small child has an acute cold the care of the nose is often difficult, if he is too young to cooperate, or if he has not yet learned to "blow the nose." There

[1] Kirkpatrick and Huettner, *Fundamentals of Health*, pp. 297–299, Ginn & Company, 1931.

should be no force used in this procedure (as will be readily seen by looking at Fig. 27) because of the danger of forcing infective material into the inner ear, the frontal sinus, the antrum, the eye, or the sphenoidal cavities. It is no longer considered good practice to use atomizers or syringes in cleansing or treating the nasal cavities, nor should one teach or permit a child to hold one nostril shut while blowing forcibly through the other. The child should be taught to blow with both nostrils open.

If the child's nose must be cleansed for him, toothpick swabs very carefully made, or bits of cotton held with small forceps, may be used. After the secretions are sufficiently removed, warm oil should be dropped in the nose with a pipette. The child must lie upon the mother's lap with the head low and hanging backward in order that gravity may force the oil through the passages (Fig. 83). Every effort should be made to do this without frightening the child or subjecting him to discomfort. While any bland, sterile oil may be used (see page 282), it is better to ask the child's physician for a special preparation for the purpose. The nose of the child who has a cold should be thoroughly cleaned before he eats or sleeps.



FIG. 83.—Dropping oil into child's nose.

As with gargling (see page 390), the child should learn to blow his nose properly and to care for a kerchief when he has no cold. He should do this as soon as he becomes imitative and do it as a frolic. Convenient pockets should be provided, and the child should be taught from his first acquaintance with a handkerchief to care for it properly. During an acute infection he should use paper squares such as toilet paper, or paper napkins cut in pieces, or the soft paper kerchiefs now on sale, or the popular face tissue, and should be given a small paper sack in which to put these when used, and he should be trained to wash his hands after blowing his nose.

Needless to say, he should be trained to "cover up each cough and sneeze" and to kiss no one upon the mouth.

The Tonsils and Adenoid. *Where and What They Are.*—The tonsils and adenoid are composed of lymphoid or glandular tissue. It is strictly correct to speak of "the four tonsils." The two faucial, palatine, or "throat tonsils" are arranged in small masses on either side of the throat; the adenoid, pharyngeal, or "nasal tonsil" is found where the nose and throat join.[1] It is so located that inhaled air strikes against this glandular, cauliflower-like mass as it is deflected into the bronchial passages to the lungs (see page 384). Although the adenoid is really one mass it is often referred to in the plural on account of its lobed structure. Another careless expression is, "This child has adenoids," which implies that normally he should have no such structure, when the meaning is that he has an enlarged or diseased adenoid mass. There is another very small mass on the back of the tongue, called the lingual or "tongue tonsil." These four glandular masses touch each other during swallowing and form a closed ring through which everything swallowed must pass (see Fig. 27 for location of the tonsils).

The tonsilar tissue is lymphoid or glandular in character and contains a variable number of white blood corpuscles, also called *lymphocytes* or *phagocytes*, which help to catch and destroy germs; the glandular tissue may have other important uses which will be better understood when science has told us still more about "internal secretions." At any rate, these glands stand as a ring of sentinels stationed to guard the port of entry to the body from infection, and it is altogether likely that they have other protective functions. The tonsils drain into the lymphatic vessels and glands in the neck, which become enlarged and "beaded" when the tonsils are infected or diseased.

Enlarged and Diseased Tonsils and Adenoid.—When any part of the body is constantly exercised, it increases in size; the blacksmith's right arm, the enlarged heart of the athlete, and the goiter of hypothyroidism are examples. So with this glandular tissue in the tonsils and adenoid. When it must work all the time to take care of germs and dust which are constantly inhaled, and especially when it is repeatedly infected with cold germs and irritated with dry hot inside air in winter, it grows or "hyper-

[1] Cooke, W. E., The Pharyngeal Tonsil (Adenoid), *American Journal of the Diseases of Children*, February, 1928.

trophies" until it can grow no larger, and somewhere along the way it is apt to break down and become diseased or chronically infected. Then instead of being a protection it becomes a danger, and the blood absorbs poisons which are very likely to produce rheumatism, heart disease, and other ailments.

Tonsils which are large but not diseased may not injure the health, and it is worth every effort to save them until the child arrives at puberty, when they naturally tend to shrink. The fact that these structures are larger and apparently more active during the growing years leads to the inference that they must have important functions associated with growth, and that the child should not be unnecessarily deprived of them.

Adenoid tissue which is enlarged, however, interferes with breathing and presses on delicate structures in the nose and at the base of the brain. The adenoid should always be removed if it is large enough really to interfere with free breathing when the mouth is closed.

Diseased tonsils should be under the care of a specialist. If they have careful and constant treatment and are not too badly diseased, they can sometimes be saved. Too often, however, there is nothing to be done but take them out. Certainly they should be removed at once if the child begins to complain of joint pains or show any signs of rheumatism. The germs characteristic of chronic tonsilar infection also have an affinity for the heart valves and joint coverings. This is the reason diseased tonsils, valvular heart disease, and rheumatism so often go together.[1]

The Causes of Enlarged and Diseased Adenoid and Tonsils.— 1. Hot dry dusty indoor air in winter. The antiquated custom of keeping little children indoors all winter "to prevent their taking cold" was the surest way for them always to have congested mucous membranes and sniffling, running noses. The air in the average house in winter time is by actual test drier than the Sahara desert, and it is never entirely free from dust. If a child living under such conditions does chance to get a breath of cold outside air in his breathing passages, which are dry and

[1] KAISER, A. D., The Relation of Tonsils-adenoid to Infections of Children, *American Journal of the Diseases of Children*, March, 1931; also editorial in *Journal of the American Medical Association*, May 23, 1931.

debilitated and therefore entirely unable to accommodate themselves to the sudden change, of course they become congested and fall easy prey to cold germs.

2. Living on the floor. The baby who creeps and toddles lives in a different climate from that 5 feet higher where the family lives! Every mother should put her face frequently close to the floor to see what kind of air her baby breathes. Not even then can she see or feel the dust which her feet keep constantly stirring around the baby. Even if the floors are kept very clean and the mother uses dustless methods of cleaning, she and others constantly go and come from the street and yard and bring much dust with them on shoes. The poor tonsils and adenoid do their best and grow and fight as long as they can, the baby becomes a mouth-breather, ultimately infectious germs gain entrance, and trouble begins in earnest.

3. Deficiency diet. As nutrition work with children advances it becomes more and more apparent that lack of vitamins and minerals in the diet lowers the general resistance of the child and makes him an easy mark for all diseases, particularly respiratory and glandular infections. Conversely, the balanced diet, which has been described in these pages, not only protects the child from rickets, scurvy, and the other specific diseases mentioned, but also makes the child more resistant to colds, dental decay, tonsilitis, diseased tonsils, bronchial pneumonia, and tuberculosis. Sun baths, foods rich in vitamin and mineral content, especially vitamin A, calcium, and phosphorus,[1] pigmented vegetables, whole cereals, and milk are therefore necessary in order to protect our child from diseased tonsils.

Symptoms of Enlarged Adenoid and Tonsils.—Holding the mouth partially open in order to breathe, snoring or breathing noisily while sleeping, frequent colds, dark circles under eyes with a heavy, listless expression, fullness of the bridge of the nose, alteration of the dental arch, usually as an "overbite," but occasionally as an "underbite," are some of the usual symptoms of nasal and throat obstruction due to adenoid and tonsil hyper-

[1] Interim Report of the Medical Committee on Enlarged Adenoids and Tonsils of the English Board of Education, 1929.

trophy.[1] A child with enlarged adenoid is in a condition comparable to that of an adult who would pack both nostrils full of cotton and wears this obstruction night and day while eating, sleeping, and talking. The adult would soon discover that his ability to think was impaired and that his sleep, appetite, and nerves were seriously disturbed.

Operation.—There is a growing conservatism on the part of good specialists about removing these glandular structures.[2] As has been said, tonsilar growth must not be removed unless there is a probability of its being not only enlarged but diseased. As the foci of infection are sometimes hidden deep within the crypts and not easily visible, it is sometimes difficult to be certain about the presence or degree of infection. Hence one doctor may advise removal and another advise delay. The only thing for a parent to do is to select a specialist in whom he has confidence and follow his advice. While the removal of tonsils is sometimes regarded as a minor operation, there is no operation requiring more delicacy of technique and nicety of judgment, and *no child should be operated upon by any one but a trained specialist.*[3] Irreparable injury has sometimes been done by bungling work with these exceedingly delicate structures.

Conservation of the Tonsils.

1. Use a play pen for the creeping and toddling child, and keep him from underfoot, and out of drafts from under doors.
2. Let every child play out of doors every day in the sunshine.
3. Protect the legs and feet with one-piece leggings if the floors are cold.
4. Keep the indoor air cool and moist. Keep pans of water evaporating on stoves and radiators.

[1] The Interim report of the Medical Committee on Adenoids and Enlarged Tonsils says: "Adenoids may occur as early as the first year of life, they seldom develop after the eighth year. Educational retardation is a fairly common result of adenoids, especially in the higher age groups. The cause in a certain number of cases is the defective hearing which so often accompanies this condition; in others there is a certain mental lethargy which may be due to some interference with the cerebral circulation."

[2] Tonsillectomy in the United States, editorial, *Journal of the American Medical Association*, Oct. 20, 1928.

[3] Kaiser, Albert D., Results of Tonsillectomy, *Journal of the American Medical Association*, Sept. 20, 1930.

5. Keep the windows down a little at the top to keep the indoor air fresh and moving all the time.

6. Look at the child's throat often, and teach him to gargle as soon as he begins to imitate.[1]

7. Plenty of vitamins and minerals in the diet and free exposure to sunlight.

If every child were protected from "dust and its dangers" and breathed only fresh, cool, inside air in winter time, and spent much time out of doors all the year round, and were fed food rich in vitamins, the incidence of diseased tonsils and enlarged adenoids would be greatly lessened if not obliterated in one generation.

Hygiene of the Ear.—*The ear* is a complicated structure evolved for the purpose of transmitting sound waves to the brain and thus placing the living organism in touch with one set of natural phenomena. One of the most amazing of the many evolutionary adaptations is the rise of a sound-producing mechanism and its correlation with a hearing mechanism, and particularly with the creation of an artificial set of reactions known as language. The way in which speech becomes transferred to pictured symbols and interpreted through the medium of light waves and the eye is the "continued-in-our next" serial of the language story (see chap. XXX).

A look at Fig. 84 reveals an intricate mechanism consisting of a receiver, the external ear, cleverly adapted to collect and transmit through the canal the maximum amount of sound wave, with the canal, which is bent to prevent the entrance of dust or injurious substances. Lining the canal is a membrane which secretes "earwax," a substance exactly adapted to the purpose

[1] This can be done as a frolic with drinking water; the family may have "gargling parties." It is a great safeguard for a child to grow up with the idea that it is fun to gargle, and also to know how to open his throat to inspection and how to gargle thoroughly and well. It thus becomes possible to discover and treat the child's throat in the beginning of trouble, and if it goes on to a more serious condition it will be far easier to care for the throat than it will if the child must have his mouth pried open and have his throat forcibly swabbed. One such procedure is enough to inspire terror of doctors in a child for years; and the struggle with a sick child may be very injurious in itself. This is just one more instance where the mother should seize the psychological moment to fix valuable habits for life.

of keeping an open passage moist and clean, and of preventing the entrance of disease germs.

Stretched across the inner end of the canal is the eardrum (tympanum) which transmits sound, even the most delicate shadings of tone, to the exquisitely adjusted ossicles (little bones) which strike like the hammers of a piano upon the nerve strings of the inner ear. The ossicles are contained in a tiny compartment (the middle ear), much as fine scales are kept in a glass case in a scientific laboratory. The nerves of hearing spread out

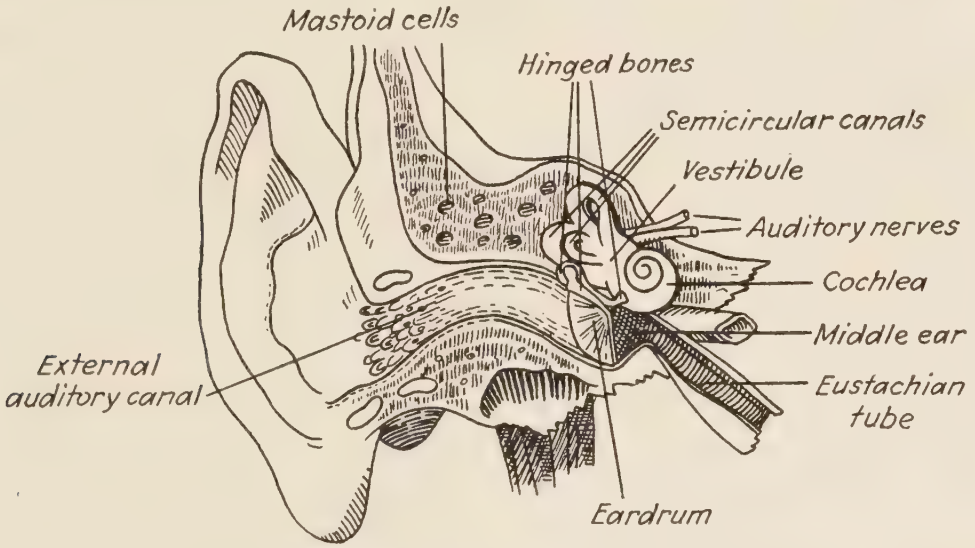


Fig. 84.—Diagram of the structure of the ear.

over the lining of the beautifully curved cochlea or snail shell and receive the impacts from the ossicles. Since equilibrium of air pressure is essential to the correct performance of this apparatus, we find an air tube (the eustachian tube) passing from the middle ear to the back of the nose, where it will receive, not external air (if that would do there would have been a little hole in the drum, which would have been much simpler) but *warm, moist, sterilized* air which has been "processed" (see page 384) in passing through the nose. In connection with the inner ear we find three semicircular canals filled with fluid which provide the balancing mechanism by which the body maintains its equilibrium. Both the hearing and balancing mechanisms communicate directly with the brain.

It will be noted in the picture that the bone in which this wonderfully delicate machine is imbedded is spongy or porous, an arrangement which provides a certain important resilience

to force. Behind the ear is a prominence in the skull known as the *mastoid*, composed of very porous sponge-like bone, full of communicating air cells which open into the middle ear. Thus an air cushion is provided behind the ear which, in cooperation with the eustachian air tube, maintains a standardized air situation within the middle ear, so that sounds may be clear as they reach the brain.

It will be apparent from looking at the diagram that Nature has made it difficult for infection or mechanical injury to reach the hearing apparatus, and has so arranged the structure that temperature, moisture, and pressure are relatively uniform during every moment of life.

Infections can reach the inner ear only by way of the eustachian tube, which is lined with a ciliated mucous membrane waving toward the exterior and providing an antiseptic secretion. The eustachian tube in the child is relatively straight and open, and infectious secretions from the nose do traverse the tube to the middle ear, causing earache and abscess, which frequently ruptures the drum. Hearing may be permanently impaired because of adhesions or stiffness remaining in the delicate hinges of the ossicles. A permanent opening may remain in the eardrum, thus interfering with the movement, air balance, temperature, and moisture in the middle ear. An abscess in the inner ear should be lanced and not go on to spontaneous rupture, as the small, clean incision closes quickly, while the ragged tear will heal more slowly and less perfectly, with a possibility of permanent adhesions.

When pus forms in the restricted space of the middle ear it is very painful and if not promptly drained by incision of the drum it may be forced into the mastoid cells, producing the dreaded "mastoid abscess," which often must be drained by opening the bone from the outside.

Hygiene of the ear begins with the nose. Every effort should be made to prevent nasal infection by immunizing diet, including an abundance of vitamin A (see page 188), by providing moist, moving, cool indoor air in winter; and by preventing contact with infected persons.

If a child does have infected nasal passages with purulent secretions, the passages should be kept as open and clean as

possible, as described on page 385 in the discussion of adenoids.

The outer ear should be protected from violence, and foreign substances especially should never pass the bend in the ear canal. No attempt should be made to cleanse the canal beyond this point; neither should anyone but a physician attempt to remove a foreign body which cannot be seen, as it is much more apt to be forced against the drum than it is to be removed. Hardened earwax may be softened by dropping warm oil into the canal and removed by very gently swabbing with small cotton pledgets. It is better to have this done by a physician. A child showing any discomfort whatever in the region of the ear should be taken to a physician, as even the accumulation of hardened earwax may injure hearing and cause nervousness.

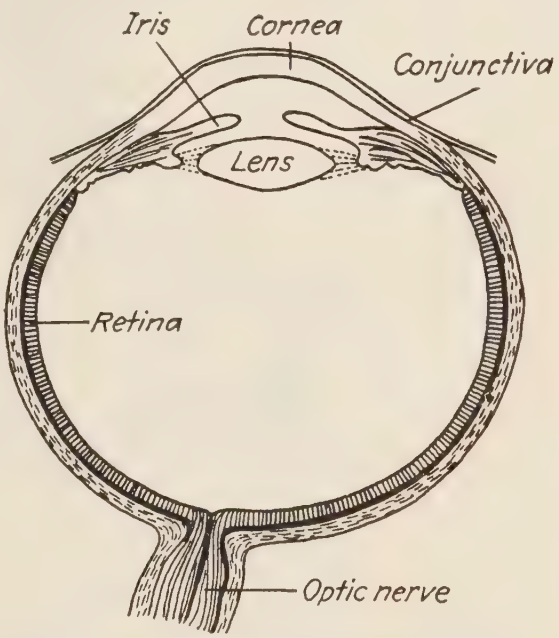


FIG. 85.—Diagram of the structure of the eye.

Hygiene of the Eye.—The eye is the most delicate camera ever created. Through its complicated and marvelously adjusted lens it photographs images of the external world upon the elaborate extensions of the brain known as the optic nerves, which spread out on the wall of the "dark room" behind the blue, brown, or gray iris curtain.

This precious mechanism is set back in the sockets with their projecting "brows" and is protected by the lids with their "quicker-than-a-wink" muscular reactions. The lids have a fringe of hair (lashes) which prevent an incredible amount of dust from coming into contact with the eyeball camera. Mucous glands and tear glands provide lubrication, and an ever ready warm "normal salt" solution for bathing the eye and removing harmful substances. Instead of overflowing the face these secretions are drained off at the lower inner angle of the eye through the tear duct which empties into the back of the posterior nares

where they may be harmlessly swallowed or conveniently removed by blowing the nose.

Infection of the eye may occur through the medium of the tear duct, which may convey germs from the nose to the eye. Or germs may be conveyed from hands, a towel which has been used by some one having an infection, or from infected dust.



Fig. 86.—Protecting the baby's eyes.

Children should be trained very early to avoid rubbing the eyes with their hands, which are never free from infectious microorganisms, and to be scrupulous about using individual towels and washcloths.

Eye strain in infants and young children is, of course, difficult to detect. No one yet knows the precise effect of exposing the eyes of infants to direct light in the modern flair for sun baths. It is the part of wisdom, certainly, to avoid subjecting the eyes of the infant and young child to conditions which we know would

be harmful to the eye mechanism of the adult. *The eyes at any age should be protected from direct light and from excessive brightness or cross lights.*

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CHAPTER XXIII

THE HYGIENE OF CHILDHOOD: SIGNS OF HEALTH

The organism is a unity, but its parts do not grow at equal rates or in simultaneous cycles; the nervous system has a continuing plasticity not found in any other organ, and adults accordingly preserve a certain capacity for psychological growth. They may not grow as rapidly and as promisingly as children but they continue to grow in accordance with similar laws. Adults, moreover, have the advantages of lengthened perspective. So far as possible parents should keep alive a sense of growth, for otherwise they will not fully appreciate the simple but profound fact that the child is preeminently a growing organism. Growth is a key concept. The psychology of the child cannot be accurately or sympathetically understood except in terms of growth.

ARNOLD GESELL.[1]

Growth. *General Growth.*—The function of young life is to grow. No young thing stops growing unless there is some deviation from normal nutrition or health. The most obvious evidence of growth is increase in size. This involves increase in linear and circular dimensions and increase in mass. There has been very active effort within recent years to arrive at correlations in rates of growth increment which should serve as indexes of normality. The problem was blocked out in the rough by tabulating the height and weight of a great many presumably normal children and correlating these with chronological age. As a result we had the standard height-weight-age tables (see chap. XXXVII, page 639), which served for some time as crude but useful measures of development.

Since height is an irreversible characteristic (a child does not lose height as he loses weight) and since it seems to be largely determined by hereditary pattern, the height of any child came to be accepted as normal. The standard tables accordingly give the height spread at each age with the average weight for each height at the given age, *i.e.*, the average weight for all male children who are six years old (five and one-half to six and one-

[1] FISHER and GRUENBERG, *Our Children*, Viking Press, Inc., 1932.

half) and who are 40 inches tall is 36 pounds; for all who are 41 inches high it is 38 pounds.

Since an "average" implies a normal range of variation it becomes necessary in applying these standards to fix upon a zone of normal variations. This was arbitrarily fixed by various workers at from 7 to 10 per cent below to 10 to 20 per cent above the average weight for height and age.

All observers agreed and still generally agree that the child who is markedly below the average weight for his height and age is very apt to have something wrong in his environment, such as wrong food and sleep habits, or some bodily defect such as infected tonsils or teeth.

At the Merrill-Palmer Nursery School percentile tables have been compiled which are more significant than the height-weight-age tables of averages. By the percentile method the child is placed precisely in his relation to other children of his age.

A much better way of comparing a child's height with that of other children of his age is to be able to state how many children of his age exceed him and how many he exceeds. For example, two-year-old boys at the Merrill-Palmer School have been found to vary from 31.5 inches to 37.2 inches in height, the average being 34.6 inches. A two-year-old boy who measures 33.6 inches is shorter than 80 per cent of boys of his own age and taller than 20 per cent. He is said to rank at the 20 percentile of the two-year-old boys in height. It is much more helpful to know that such a child is at the 20 percentile of his age group (or that 80 per cent of the children of his own age exceed him in height), than that he is one inch below the average height.[1]

As experience has accumulated, however, growth has proved to be a highly complex affair, with many variations and rhythms manifesting themselves in the different structures of the body Maturation of function also must be taken into consideration as well as mere increase in size. Accordingly, less meaning is now attached to conformance to the average height-weight-age averages and more to other signs of normal development which will be discussed.

[1] See Rand, Sweeny, and Vincent, *Growth and Development of the Young Child*, p. 283, W. B. Saunders Company, 1930.

Dr. Scammon discusses prenatal growth and describes six methods of postnatal growth exhibited by different parts of the body. A brief account of these will serve to illustrate the com-

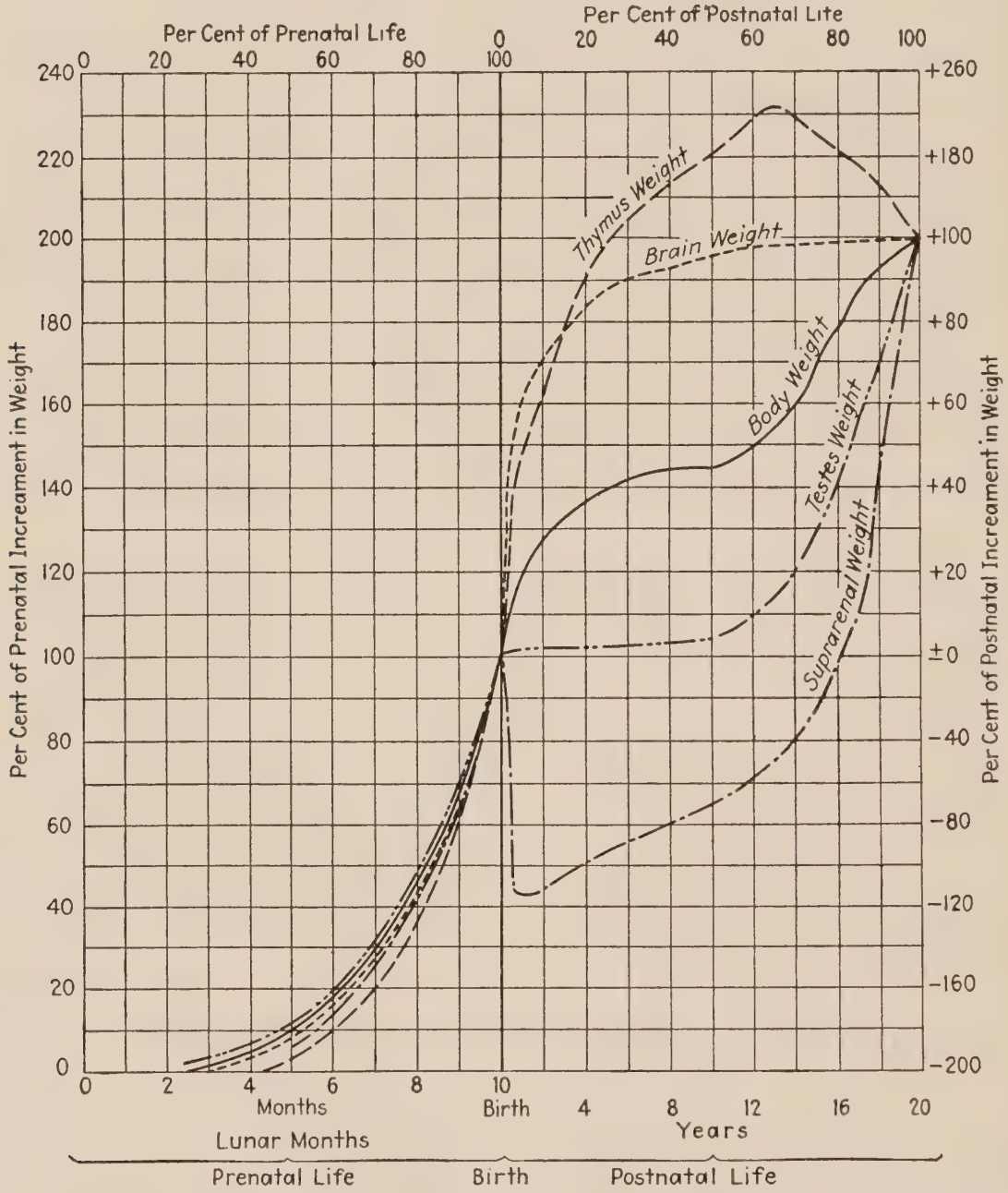


FIG. 87.—A diagram illustrating the growth in prenatal and postnatal life of a series of structures of diverse postnatal types of growth. (*Adapted from Scammon, Measurement of Man.*)

plexity of human growth. Dr. Scammon, for purposes of comparison, has reduced all measurements to 10-panel graphs, several of which we are permitted to reproduce. The 10 lunar prenatal

months are graphed on the same scale as the 20 postnatal years of growth in order to show comparable trends.[1]

Prenatal Growth.—It will be seen by consulting Fig. 87 that the fetal or prenatal growth of the various organs and structures, as shown by series of measurements beginning with the third month, show very similar and characteristic lines of growth. Dr. Scammon says,

> Growth in mass follows a fairly simple course, increasing very slowly in the first three lunar months, entering a period of very rapid change in the rate of growth in the middle third of fetal life, and thereafter undergoing an extremely rapid augmentation until birth. In the last month of fetal life the increase in weight takes place at a rate of over 1 per cent a day. With this rate of growth continued until the end of the first year the weight of the body would be nearly 200 pounds, and were it to continue to 20 years the volume of the body would approximate the magnitude of the earth.[2]

Postnatal Growth.—Certain difficulties in interpretation of postnatal growth changes are encountered. As indicated, the various parts and organs of the body develop at different rates and rhythms. While the curves here reproduced from the work of Dr. Scammon are plotted on a basis of total increment over the given period of growth, and certain of them show similarity of the contour of their periods of acceleration and retardation, yet the rates may differ markedly. For example, between birth and maturity height increases 3.5-fold, surface area about 7-fold, while weight increases about 20-fold.[3] Another consideration is the fact that

> Equal units of increment at various stages of development often represent very different entities [units of value]. A pound's gain in weight in an infant is quite a different thing from an equal gain later in life. In the baby this increment represents a gain in brain substance and viscera, as well as an enlargement of other parts of the body; in an

[1] Scammon, R. E., *Proceedings of the Second Conference on Research in Child Development.* National Research Council, 1927; Scammon, R. E., *The Measurement of Man,* chap. IV, The Measurement of the Body in Childhood, University of Minnesota Press, 1930.

[2] Scammon, R. E., *Proceedings of the Second Conference on Research in Child Development,* p. 10, National Research Council, 1927.

[3] Scammon, R. E., *The Measurement of Man,* University of Minnesota Press, 1930.

adolescent it is primarily an increase in bone and muscle; while in the middle-aged it is often but an accumulation of adipose tissue.[1]

We should also take into consideration the varying composition of the tissues of the body; the difference in water content, bone mass, fat, and muscle at various ages and in different individuals. Three general types are now recognized in most attempts at practical application of normal criteria: a normal thin type, a stocky type, and an intermediate type. All these considerations, together with consideration of the types of growth of the various parts of the body as illustrated in Scammon's curves, make it

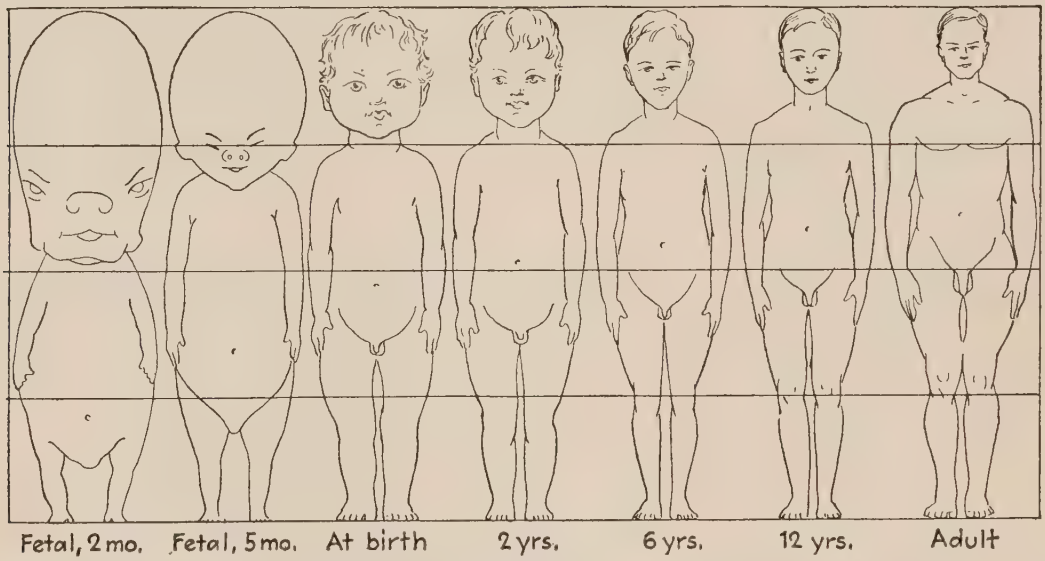


FIG. 88.—Changes in proportions during prenatal and postnatal growth. (*After Stratz.*)

clear that the correct interpretation of growth is not a simple matter.

General Growth.—Subsequent to birth, general growth of the body follows an entirely different course from the curve shown in prenatal growth. Body weight, increase in mass of liver, pancreas, kidneys, stomach, vascular system, muscular system, and most of the external dimensions show a four-phase type of growth characterized by rapid increase during the first two years of life, a slow but steady growth until the prepubertal age, a rapid growth during puberty, and a slowing down during late adolescence and early maturity.

[1] SCAMMON, R. E., Recent Work on the Physical Development of Children, *Proceedings of the Third Conference on Research in Child Development*, Part I, p. 1, National Research Council, 1929.

Neural Growth.—The brain and all its parts, the spinal cord, the eyeball and the pineal gland follow a different curve, characterized by very rapid growth during early childhood, especially from birth to eighteen months, succeeded by rapid slowing down. The relatively large size of the head and relative changes in body proportions are graphically shown in Fig. 88, page 400, chap. XXIII.

Lymphoid Growth.—The lymphoid structures which have been measured show still another type of behavior, marked by rapid growth in infancy, reaching a peak about the time of puberty, but marked by a decline or atrophy extending more slowly into maturity. The thymus, the lymph nodes, the white or lymphoid part of the spleen, and to some extent the tonsils show this general increase and decline.

Genital Growth.—A fourth method of growth is shown by the ovaries, testes, and certain other urogenital structures. These show a slight growth during infancy, followed by a latent period from the ages of one to about ten years, with rapid growth during puberty, adolescence, and into maturity.

Miscellaneous.—A few other structures of the body follow nontypical or individual methods of growth, notably the neck and endocrine glands. Figure 89 exhibits graphically these types of growth.

The Hygiene of Weight.—While not so much definite importance is now attributed to conformity to the growth tables or averages in the case of the individual child, it is considered of the greatest importance that every child gain continuously. It is rare that any child's weight curve presents a perfectly straight line or a uniform course. It is probable that normal growth pursues a somewhat rhythmic course, as do nearly all forms of energies, with natural accelerations and regressions. It is difficult to be certain about this, since so many experiences have the effect of retarding growth and arresting weight increase.

The mother should weigh the infant every week during the first months of life. After his condition and nutrition are stabilized he should be weighed every month during his preschool years. No child should fail to make a gain over weekly or monthly periods. Certainly no child should ever lose. A slowing or unusual retardation of increase in weight other than is

indicated in the standard tables or curves should lead to scrutiny of the child's general condition. The child may be passing through a rhythmic period of increase in height which will be followed by a period of rapid increase in weight. A period of

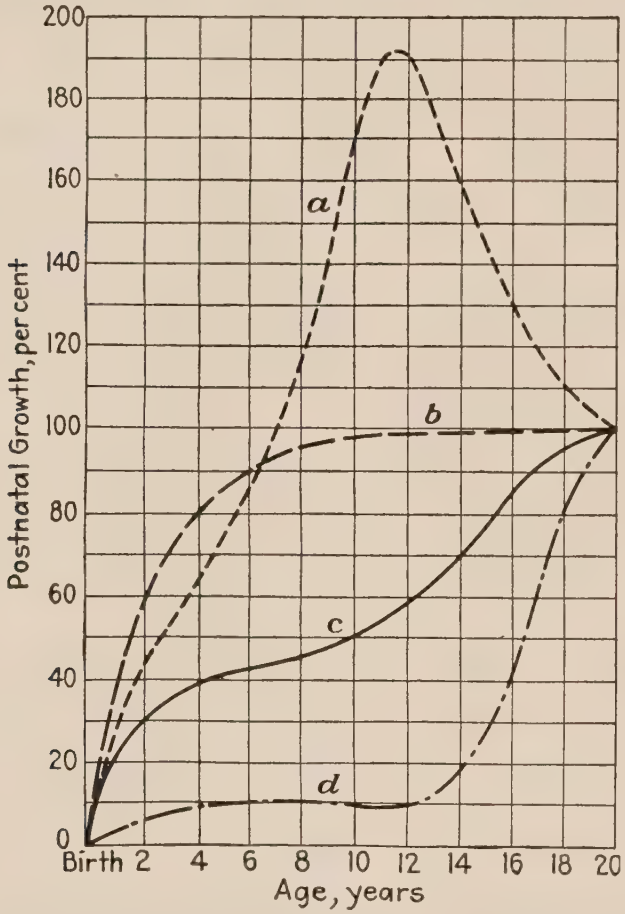


FIG. 89.—A graph showing the major types of postnatal growth of the various parts and organs of the body. The several curves are drawn to a common scale by computing their values at successive ages in terms of their total postnatal increments (to twenty years). (*a*) Lymphoid type: thymus, lymph nodes, intestinal lymphoid masses. (*b*) Neural type: brain and its parts, dura, spinal cord, optic apparatus, many head dimensions. (*c*) General type: body as a whole, external dimensions (with exceptions of head and neck), respiratory and digestive organs, kidneys, aorta, and pulmonary trunks, spleen, musculature as a whole, skeleton as a whole, blood volume. (*d*) Genital type: testis, ovary, epididymis, uterine tube, prostate, prostatic urethra, seminal vesicles. (*After Scammon.*)

rapid increase in height must necessarily show a period of low height-weight correlation. "The child must have time to put meat on the new bones." Normally there will usually be a period of increased appetite and food intake accompanying or following spurts of increase in height. Without making a fetish of the weight average the mother should watch and intelligently interpret the weight of her growing child.

Symmetry of Growth.—Because body height and size are to a certain extent hereditary, the body throws up its scaffold, so to speak, no matter how poor may be the building material available. If the child's nutrition is defective because of poor food, poor appetite, fatigue, or rickets, the result is apt to be a "spindling" distorted body, poor muscles, and poor posture, but he may arrive at his hereditary height-pattern somewhat as a potato sprouting in the cellar produces a long, pale runner. The excuse that he comes from a thin family often leads to serious neglect. The healthy thin type of child presents quite a different appearance. He is straight, symmetrical, firmly muscled, happy, adaptable, and vigorous.

Reasons are given in chap. XX for considering good posture as a sign of health. Good nutrition and free exercise will guarantee good posture, firmness, and symmetry, and all these are essential to optimal health.

Other Signs of Health. *General Tone.*—Perfect health is characterized by a certain tonus or "tone" which shows in firm muscles, vigorous poise, a certain "ready-to-go-ness" which is quite different from the exaggerated tension of nervousness, and markedly different from the relaxed, slumping attitude and demeanor of the fatigued child. Indeed, malnutrition is often more readily determined by the lack of firmness of the flesh and subcutaneous fat than by the weight alone. The skin should be firmly attached to the underlying muscle, no matter whether the child is slim or stout.

Color.—It is impossible to diagnose anemia from the color of the face. The thickness of the skin and the distribution of pigment vary greatly. In the healthy infant and child, however, there is a certain glow or warmth in the color of the body which is characteristic of health. The mucous membranes of mouth and eyes should be bright pink, and the skin should be smooth and soft.

Expression.—A healthy child is a happy child. Conversely, the child who is unhappy or badly managed will not long remain a healthy child. The happy child will have an appearance of well-being, a poise, a cheerfulness, a glow or radiance which is the supreme charm of childhood.

Activity.—The healthy child is active during every waking moment. Normally, if he has a variety of interesting occupations, he will go happily from one thing to another, as will be discussed in later chapters on Behavior. He will need something to do every moment, but he should not be high-strung, irritable, or wantonly destructive. Either listlessness or hyperactivity is a sign of fatigue or other deviation from health which should receive careful consideration.[1]

Dr. W. R. P. Emerson lists the following signs of physical fitness which may serve any parent as a suitable scale by which to determine the normality of a child:[2]

Glow of health—eyes clear, color good.
Expression of face, happiness and well-being.
Hair, smooth and lustrous.
Mouth closed.
Teeth good.
Skin clear, firm.
Muscles, good tone, flesh firm.
Posture erect, suggests power and endurance.
Gait alert, full of life.
Feet, good arches.
Optimum weight for height.
Outdoor-minded.
Normal reactions, good physical and mental stability.
Enjoys life, fond of play.
Picture of health, looks young, vigorous.

The Health Examination.—The importance of promoting normal development and preventing deviations from health is coming to be generally accepted by modern parents of young children. There should be a health examination center available for infants and preschool children in every community. Every infant and preschool child should receive regular health examinations either at such a center or in the office of a pediatrician. Many family physicians are now trained in giving such examinations. It is better policy to pay for preventive service than to pay doctor's fees for illness. The report of the White House Conference in the section on Medical Education shows that an

[1] Seham, Max and Grete, *The Tired Child*, J. B. Lippincott Company, 1926.

[2] Emerson, W. R. P., *The Diagnosis of Health*, p. 7, D. Appleton-Century Company, 1930.

increasing number of medical schools now train their students to give health examinations and require their attendance at well-baby clinics. The report advocates including this training and experience as a prerequisite to graduation.[1]

The Health Record.—The weight and growth record of every child, together with his developmental history, should be kept as a matter of course by every mother for each child. Many baby books are available; some very attractive records are given gratis by commercial concerns. A thoroughly scientific record containing forms for the significant developmental data, both physical and mental, from birth to sixteen years, has been designed by the Minnesota Institute of Child Welfare and is sold by the Parents' Magazine Publishing Company 255 4th Avenue, New York City. Such records have personal, scientific, and historical value, and are worth all the time and effort it takes to keep them. If a detailed family history (see chap. III) is also kept, the parents will be able to turn over an invaluable record to the child when he reaches adulthood and establishes his own home and family.

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PART III

DEVELOPMENT, BEHAVIOR, AND TRAINING

CHAPTER XXIV

BEHAVIOR

"While my voice proclaims
How exquisitely the individual Mind
(And the progressive powers perhaps no less
Of the whole species) to the external World
Is fitted:—and how exquisitely, too—
Theme this but little heard of among men—
The external World is fitted to the Mind;
And the creation (by no lower name
Can it be called) which they with blended might
Accomplish:—this is our high argument."

WORDSWORTH.[1]

The Significance of Behavior.—We have had a brief glimpse in earlier chapters of the origin, continuity, and variations of the forms of life which have arisen out of the surface of the earth, struggled toward greater complexity, reached out for the stars, tried to "fill the universe," only to subside into the earth again, conquered for the moment, redistributed among its inert elements. We have seen Life live again and yet again in the seed it left behind, conquering more with each incarnation until Life gives to us—*a human child.*

There is a theory (entropy) held by some scientists that the world is gradually running down, and that the law-of-least-resistance will eventually, millions of centuries hence, bring all energy to equilibrium. This would clearly be the end of the world. Doctor Herrick suggests that not only are there inorganic mechanisms for reversal of entropy (such as "cosmic rays") but that living things are continually reversing this perpetual pull or drag upon energy which thus far conquers all life forms in turn. "The human brain does the highest type of this sort of work known to nature. . . . Perhaps this is the chief work of the mind when viewed from the standpoint of cosmic dynamics." He believes that "our cosmos is not running down, but

[1] *The Recluse.* By permission of Houghton Mifflin Company.

is potentially immortal at a high rate of creative power."[1] He and other modern philosophical thinkers, notably the "emergent evolutionists," see man as the most complex expression (as yet) of a force which is struggling toward the realization of some gigantic cosmic purpose. G. T. W. Patrick says "There seem to be formative forces struggling for expression . . . a kind of cosmic Creative Effort."[2]

Bergson is quoted by Patrick as believing that there is "'some original and essential aspiration of life, which is the mainspring of evolution itself, leading up to the presence of organic life and finding its full expression only in human society.'"[3]

Without wading too far into philosophical deep water we may at least agree that human life is deeply significant and that our child's life reaches far into the past, probably farther into the future, certainly into both earth and heaven, and that his life has profound integration with his physical and social environment.

We have had a glimpse at the wheels of life in their endless round of birth, growth, reproduction, death. We have considered somewhat Nature's central scheme, plot, or motif, Heredity and Evolution, with which she produces endless but consistent diversifications of living forms and baffles the forces of entropy. We have familiarized ourselves somewhat with the delicate chemical and electrical reactions between hereditary protoplasm and living and nonliving environment which we call nutrition and growth and function.

We come now to a consideration of the way this aggregation of protoplasmic dust-of-the-earth, which we call a child, *behaves.* After all, it is his behavior which is important. Nature seems to be perpetuating life through reproduction and heredity, and maintaining it through the intricate mechanism of glands, organs, and muscles in order that the individual may *do something—function in the social organization.* We want this child to do more than *merely* eat, breathe, sleep, and move. Experience has taught us that he *will* do more than simply exist. He must react

[1] Herrick, C. J., *The Thinking Machine,* p. 49, reprinted by permission of the University of Chicago Press.

[2] Patrick, G. T. W., *What Is the Mind,* pp. 80–81, 85, The Macmillan Company, 1929.

[3] *Ibid.,* pp. 85–86.

and interact with other living organisms and with his outer world. Without this he can no more live, move, and have his being than his heart, his arm or his muscle cells can exist and function apart from the rest of his body, which is their essential organic environment. We become interested in his social and intellectual growth and behavior as well as in his physical growth and health; we wish to help him in what we are pleased to call his "learning" or "education."

We desire his existence to be long as measured in time, and his physical strength and health to be great, therefore we have considered at some length the management of his environment as represented in food, sunlight, and air. In order to do this we had to review what is known of the essential chemistry of protoplasm and its intricate requirements. We had to consider what is known as to the optimum size, strength, and longevity possible to the human animal and to formulate rules of conduct in conformity with what we know of the organization of the human body.

The Physical Basis of Behavior.—Since we also want this child to be effective in his behavior as a unit in the greater biological organization of society, we must review the chemistry and structure which constitute the specific physical basis of behavior; we must consider what this society of which he finds himself a member believes or accepts as optimum and normal behavior; and we must try to formulate rules of conduct which will secure, in so far as the limitations of human wisdom and experience permit, that behavior which will best promote the happiness, welfare, and advancement of human society.

With the picture of the magnificent origin of our child and of his physical integration with a magnificently organized Creation in our minds, we shall accordingly continue to follow the thread of biological development further into the child's unfolding life.

Let us go back to the stuff-of-life, protoplasm (chap. I), that mass of colloidal dust which somehow acquired the property of maintaining in a constant ratio its own particular combinations and proportions of minerals, fats, carbohydrates, "bound water" and especially, in each of its forms, the particular combination of amino acids necessary to form the specific protein. Along with this, we recall that protoplasm has the ability to manufac-

ture or acquire potent activating substances known as enzymes, catalysts, hormones, and vitamins. The smallest mass of living substance which it has been possible to see with the most powerful microscope shows the above composition and also manifests "behavior." It responds to stimuli, both favorable and unfavorable, essentially as do higher organisms.

We are led to conclude from all the evidence that the property of response, adaptation, change, must reside in the chemical pattern of this protoplasm and that it is in this that the living differs from the nonliving. The intensive research of Professor Child and others[1] seems to have determined a good deal concerning the *manner* of this chemical response, although the *source* of the initial urge is still quite unknown. These investigators show conclusively that behavior resides in, or is at least manifested in, alterations of chemical composition and intensity. The more rapid and consecutive the chemical action in one region or from region to region, the more rapid and effective is the response, activity or "behavior" of the organism. Child has given the name *physiological gradient* to these regions or centers of heightened chemical reaction (see page 33). It is through this capacity for adjusted chemical response that the integrity of the organism is maintained in the midst of the disintegrating, "entropic" influences of environment. Although the source of these centers of variation or heightened response is still completely unknown, we have seen these emerge from the dynamic pattern mechanism of the egg, and it clarifies our concept of behavior to see the mechanism operate, even though the source of initiation and control is still beyond our ken.

By a *physiological gradient*, then, we mean division into regions of differing chemical and electrical activity, in which the protoplasm involved reacts with increased and graded or "graduated" intensity to its environment, which may be surrounding water, air, or earth, in the case of a one-celled organism; or blood plasm or surrounding cells, if it is a cell among other cells in a many-celled organism. The polarity of the cell or group of cells involved may be changed by the gradient so that the negative and positive poles are reversed or shifted; the action of the cell

[1] Child, C. M., *Physiological Foundations of Behavior*, Henry Holt & Company, 1924.

enzymes may be speeded up by glandular stimulation or enzyme reaction so that oxidation is increased and there is heightened metabolism, with increased absorption and consumption of nutriment. The pseudopodia of the ameba, for example, are activated by temporary metabolic gradients called into being by conditions within and without, the colloidal substance in the extruding portion becomes more fluid and flexible than the remaining portion of the ameboid body.

The gradients of activity may be identified in small experimental organisms by immersing them in weak potassium-cyanide



FIG. 90.—Two embryos of *Amblystoma microstomum* showing (from left to right), by stippled areas, the progressive disintegration of the tissues under the action of potassium cyanide, as indicative of metabolic gradients. (*From Coghill, Anatomy and the Problem of Behavior, The Macmillan Company and the Cambridge University Press.*)

solution, whereupon the tissues disintegrate first in the active, flexible, newer portions where the chemical activity is highest, and in the stable older structures last. Figure 90 shows how accurately this procedure identifies the gradients of activity in an Amblystoma.

All of this is of interest to us because Herrick, Child, Coghill, and others now tell us *there is no break between these gradients or centers of chemical and electrical force and the highest thought of man.* Child is quoted by C. J. Herrick as saying:

"The physiological gradient is a case of protoplasmic memory, since it represents the persistence of the effects of environmental action. The establishment of a gradient in a protoplasm may be regarded as a process of learning. In some protoplasms the memory persists only for a short time and gradients are only temporary. In other cases, once the gradient is established, the protoplasm never forgets, unless subjected to some environmental action powerful enough to obliterate the former memory. . . . The establishment of a persistent gradient is, in

fact, the first step in the education of a protoplasm and the foundation of later behavior to the end of individual life."[1]

Dr. Coghill says that

the mechanism that determines the primary behavior pattern is organized under the dominance of preneural metabolic gradients.[2]

It thus appears that this physiological response to environment may be fleeting and temporary, or it may be of such a character that the manner, appearance, character, and duration of future gradients are affected.



FIG. 91.—Diagram of an ameba showing radial reaction paths converging on the nucleus. (*Modified from Douglas, The Physical Mechanism of the Human Mind.*)

The Evolution of the Nervous System. *Protoplasmic Sensitivity, Temporary Gradients.*— We shall see the relation between gradients and behavior more clearly, perhaps, if we consider a few of the steps in the evolution of the human brain and nervous system beginning with the simple behavior structure of ameba.

The body of an ameba is constantly moving about in response to internal or external changes. There is a transient polarity or head-tail axis whose structural materials are changing from moment to moment as the advance is made first in one direction, then in another. Here Dr. Hyman (1917) has demonstrated the presence of metabolic gradients of the same type as in more highly organized bodies with structurally permanent form and antero-posterior axes. The tip of each pseudopod has higher susceptibility than its base, and the newer pseudopodia than the older ones.[3]

Even in ameba, Douglas tells us, action paths of heightened conductivity convey impulses to and from the nucleus, a primitive receptor-motor reflex.[4]

Certain cells, as the heart cells, retain their original protoplasmic sensitivity to some extent, and their tendency to act as

[1] HERRICK, C. J., *Brains of Rats and Men*, p. 178, 1926, reprinted by permission of the University of Chicago Press.

[2] COGHILL, GEORGE E., *Anatomy and the Problem of Behavior*, p. 60, The Macmillan Company, 1929.

[3] HERRICK, C. J., *Neurological Foundations of Behavior*, pp. 73–74, Henry Holt & Company, 1924.

[4] DOUGLAS, A. C., *The Physical Mechanism of the Human Mind*, pp. 39, 40, E. S. Livingston, 1932.

one-celled organisms, even after they become involved in complex organization. Dr. Carrel's chick-heart cells have been contracting ("beating") with undiminished regularity and force for more than 20 years (see page 21) with no nerve tissue in them, and no central control.

Permanent Gradients.—While all protoplasm possesses a certain general sensitivity, and every cell retains in greater or lesser degree the ability to form gradients of response, even in simple unicellular organisms certain channels of permanently heightened sensitivity of response begin to appear (see Fig. 92). Herrick says:

> This change in "set" or organization of the reacting substance probably involves a slight chemical readjustment of autocatalytic type such as to make a repetition of the discharge easier. It may be transitory or long-enduring. This is organic memory. The same principle may work out in modified form in the cerebral cortex in connection with conscious memory, but of the details of this process we know nothing. . . . In the living body the processes of excitation and conduction are all of like fundamental type, regardless of the specific protoplasmic activities from which their energies are derived and maintained. . . . The mechanism of the simplest protoplasmic reaction to excitation is today as profound a mystery as is that of any complex cortical association center—and the solution of the latter problem is likely to come by way of the former.[1]

We see that many unicellular organisms develop cilia or flagella by which they move about, which may be considered to be the pseudopodia of the ameba set in permanent instead of fluid form and containing permanently active gradients. This is an advance, as the cell so equipped moves much more rapidly than an ameba.

In higher unicellular animals such as vorticella, Fig. 92, a permanent apico-basical gradient is established which passes from the free end to the fixed end in the form of a strand of contractile protoplasm running from the bell through the stalk. There is also a fringe of sensitive cilia around the mouth of the bell of the vorticella. Slight irritation at the mouth is communicated by the cilia to the body protoplasm and thence to the stalk, whereupon the bell closes and the stalk contracts in withdrawal from the danger. Here is a faint beginning, even

[1] Herrick, *Neurological Foundations of Behavior*, pp. 51–57.

in a one-celled organism, of differentiation between sensory and motor reaction.

A little further along, in certain coelenterates (hollow or tube-like multiple-celled animals), we find a highly sensitive mass of protoplasm developing at the base of the cilia, resembling sensory cells of a sort, with branches coming extensively into contact with the cells lining the body cavity and also having, presumably, some motor function.



FIG. 92.—Vorticella: (*a*) expanded; (*b*) contracted. (*After Lane, Animal Biology, P. Blakiston's Son & Co.*)

The Nerve Net.—The next step in the evolution of a nervous system is the appearance of a uniform network of sensitive protoplasm which brings all parts of the body structure into communication. This *nerve net* lies in close connection with the muscular or motor structures. Typical examples of this are found in the jellyfish and various polyps, Fig. 93.



FIG. 93.—Nerve net of Hydra. (*From Hadzi, Arbeiten aus der Zoolog.-institut der Universität Wien, vol.* 17.)

Herrick says that this nerve net has a functional polarization such that an excitation applied to it anywhere will be irradiated in every direction, and any part of it can conduct in one direction at one time and in the opposite direction at another time. This is in contrast to the nervous mechanism of higher animals, in which the nerve impulses are structurally polarized so that they travel in one direction only (the nerve net is said to be nonsynaptic, or cyncitial).

The Nerve Ring.—In some medusae there is condensation of part of the nerve net into a nerve ring running around the margin of the umbrella or mouth, with processes running into the contractile tentacles and a nerve net running through the body structure. There is an axial gradient of high metabolism running from the nerve ring along the nerve net and toward the apex. In some forms of medusa local or subgradients of heightened sensitivity begin to appear in the tentacles.

These special neural or preneural paths of rapid electrical and metabolic action greatly increase the experience and range of activity of the animal, although they are still very primitive. The nerve net has no discoverable cell boundaries; it seems to be a circumscribed stream of protoplasm with nuclei at the nodes of the net. Its rate of transmission of nerve impulses or excitation is from 0.146 to 0.211 meter[1] per second; in the nerve ring of the

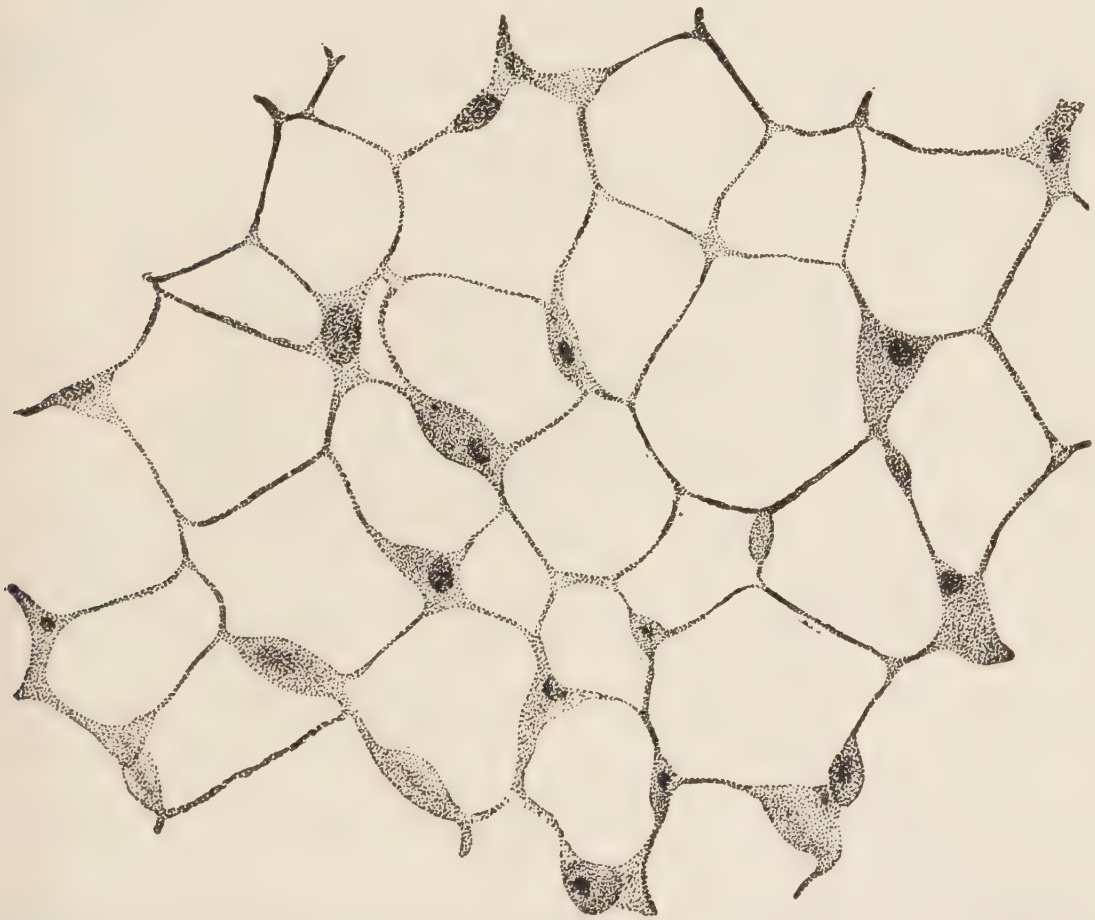


FIG. 93(*b*).—Nerve net of Hydra, greatly magnified. (*From Rogers, Textbook of Comparative Physiology, McGraw-Hill Book Company, Inc.*)

jellyfish it is about 0.5 meter per second; in the sciatic nerve of the frog it is about 25 meters per second, and in some human nerves it is 125 meters per second.[2]

The Reflex Arc.—To pay out several lengths of evolutionary thread, we shall now look at the nervous system of the segmented earthworm. Here we find a series of bilateral reflex mechanisms, one set for each body segment. The nuclei at the net nodes have

[1] A meter equals 38.37043 inches.

[2] HERRICK, C. J., *op. cit.*, p. 103.

become replaced by nerve cells which are grouped in ganglia (groups of nerve cells), from which conduction fibers extend to the muscle segment. Sensory cells, in the skin covering the segment and also in the muscles, send fibers into the central or motor ganglion where communicating or commissural cells complete a local reflex arc or circuit. Conduction fibers run between the ganglia in these body segments over which stimuli are transmitted headward and motor impulses are conducted tailward. This one-way conduction is facilitated by the interpolation of valve-like barrier membranes (see Synapses, page 426)

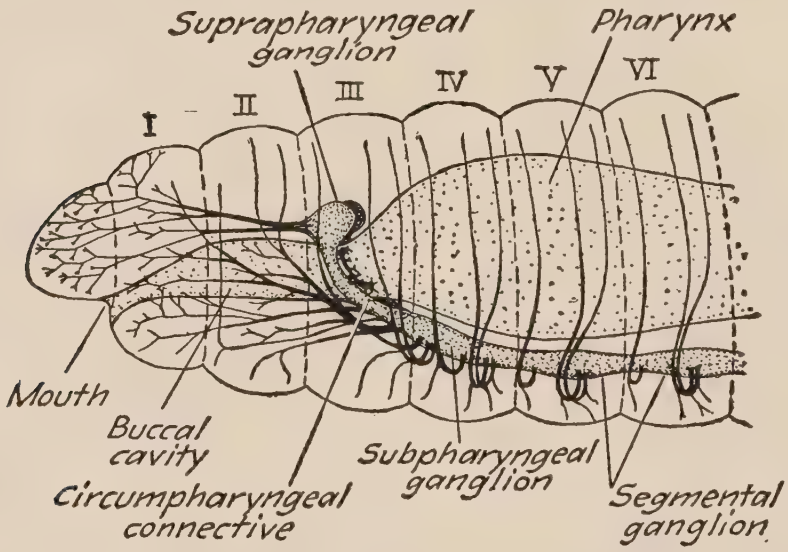


Fig. 94.—Brain and nervous system of earthworm with three body segments. (*From Hess, in Jour. Morphology, vol.* 40.)

between the ends of the fibers or cell processes where they communicate with each other.

The First Brain.—At the head end of the worm several ganglia, possibly derived from the primitive nerve ring, fuse and form an exceedingly simple brain, which acts as a determiner in some of the general activities of the worm, although to a considerable extent each ganglion acts as a brain for its own segment.

We have here a clear indication of the general pattern of the nervous system of all higher animals. That this is true functionally as well as structurally is shown by the fact that even the earthworm can learn. Yerkes taught earthworms to avoid an electric shock in a simple maze after 20 to 100 repetitions. That the centralization of control is imperfectly established at this stage and that the spinal ganglia are, in a sense, "little

brains," is shown by the fact that after decapitation the worm still makes the correct turn.

That the segments of the body are still under the primitive domination of the "whole" and that each cell has (as we have seen in chap. III) a full set of traits or genes is shown by the fact that the anterior segment develops into a new head with a new brain after the original head is cut off. If the worm is severed near the middle of its length, the segment to which the original head is attached will grow a new tail, while the tail end grows a head, and two complete worms result.

The Gradients Again.—Development is supposed to occur in the direction of highest gradient activity; since motor and sensory nerves develop and conduct stimuli in opposite directions, it

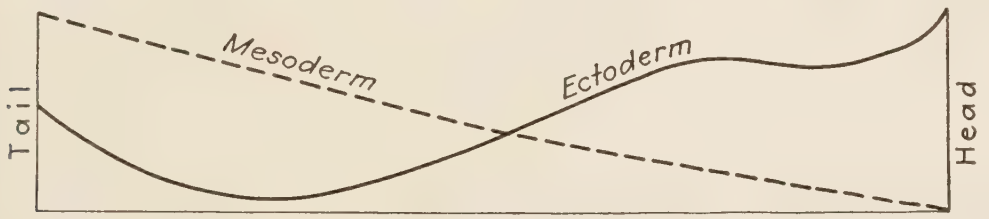


FIG. 95.—Diagram illustrating the metabolic gradients as they appear in Amblystoma. In the ectoderm the metabolic rate is highest in the head end. In the mesoderm it is highest in the tail end. (*From Coghill, Anatomy and the Problem of Behavior, courtesy of The Macmillan Company and the Cambridge University Press.*)

has been a matter of some difficulty to explain this apparent contradiction.

It will be remembered (page 36) that the fertilized human ovum soon changes its spherical surface-interior gradient for that of an anterior-posterior-bilateral, or axiate, pattern. We saw how a wrinkling of the outer or ectodermal layer showed where the brain and spinal cord would develop by means of activity gradients which appear within this layer.

A cut section of the embryo at this stage would show that three cellular layers are appearing (page 35) known respectively as the ectoderm or outer layer, from which the skin and nervous system develop; the entoderm or lining layer; and between these the mesoderm, from which the bone, muscle, and motor structures develop. This general form of differentiation holds true for all animal forms having backbones and skeletons (see Fig. 4).

Dr. Coghill tells us that in Amblystoma (a convenient type of experimental vertebrate animal, see page 37) in the ectodermal

or outer layer the rate of activity of the metabolic gradients lessens from the head tailwards (with a secondary gradient in the tail), while the activity of the gradients in the mesoderm lessens from the tail headwards (see Fig. 95).[1] There is at first a "limiting membrane" between the ectoderm and mesoderm, although they later become intricately integrated. Dr. Coghill says: "There are two longitudinal metabolic gradients operating in the embryo of Amblystoma at the time when the conducting mechanism of the nervous system is beginning to take form."[2]

As the ectoderm infolds to form the neural tube the portion of it which is to form the sensory nerve cells lies next to the outer surface, while the portion which is to form motor nerve cells comes to lie deeply anterior or next to the mesodermal layer and adherent to the mesoderm, from which the vertebra and muscle segments are to arise. Therefore the nerve cells which develop in the portion of the neural plate next to the mesoderm are under the domination of the mesodermal gradients (active from tail headward), while those that develop in the posterior or surface part of the ectodermal fold are under the dominance of the ectodermal or cephalic gradients (active from head tailward). This infolding of the neural tube has, in other words, changed the environment of all the internal cells of the embryo.

"All of these changes are an expression of a specific physiological polarity in response to or in correlation with the changes in environmental conditions. . . . The indifferent epithelial [ectodermal] cells here become polarized in response to relations with the mesoderm" into motor nerve cells.[3]

To proceed with this dramatic and purposeful march of events, mesodermal segments with heightened metabolic gradients form where the vertebrae will eventually develop, and into each of these processes motor nerve cells grow like rootlets of a plant. Secondary gradients soon appear within the spinal segments, which control the further differentiation of the motor nervous system (Fig. 96).

The inherent potentiality of growth of neuroepithelial cells and the dominance of mesodermal gradients over them, in activating polarity

[1] Coghill, *op. cit.*, p. 43.
[2] *Ibid.*, p. 44.
[3] *Ibid.*, p. 52.

and directing growth, determine the primary pattern of the motor mechanism, which . . . integrates the early behavior of the animal.[1]

Dr. Coghill's description of the appearance and development of the primitive nerve cells from the embryonic ectodermal matrix is exceedingly interesting.

The differentiation of one of these cells into a nerve cell involves the massing of the protoplasm, together with the nucleus, near the external

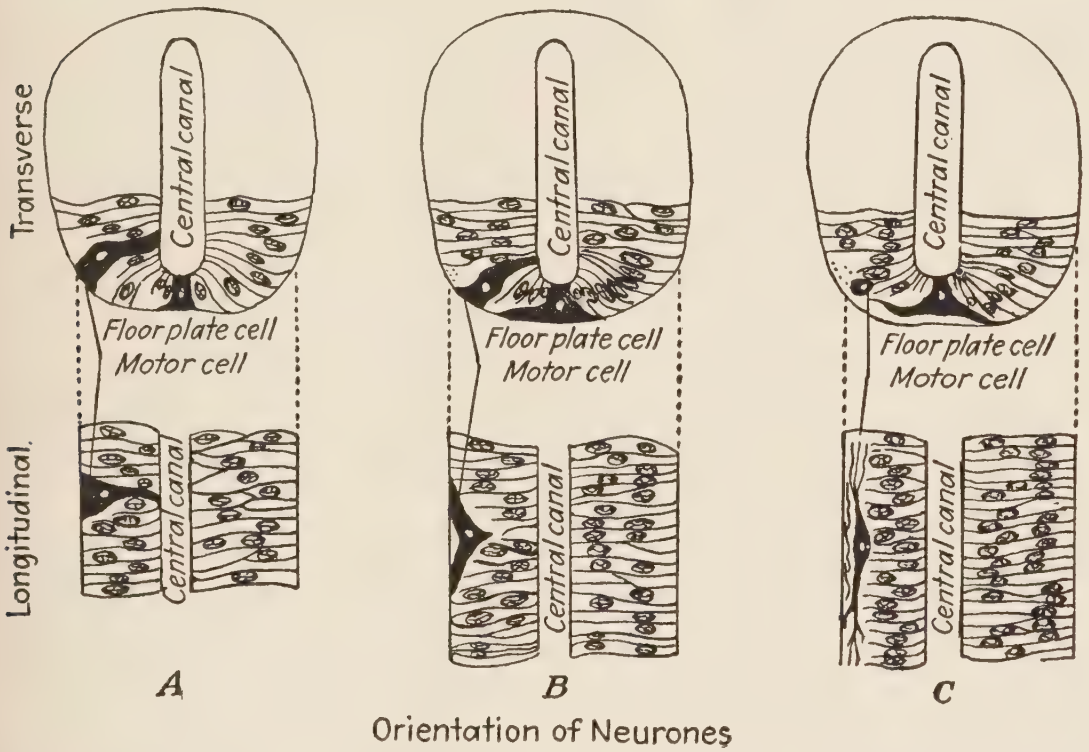


FIG. 96.—Diagram of nerve cells in process of growth. Upper figures represent cross sections of the spinal cord; the lower figures represent longitudinal sections at corresponding levels. *A*, *B*, and *C* represent successive stages in the development of an embryonic epithelial (neuro-epithelial) cell into a neurone. (*From Coghill, Anatomy and the Problem of Behavior, courtesy of The Macmillan Company and the Cambridge University Press.*)

limiting membrane [between the mesoderm and the ectoderm]. That part next to the membrane becomes the growing tip of the cell. It spreads out along the inner face of the membrane [much as an ameba

[1] *Loc. cit.* p. 57. This propensity of the embryonic nerve cell to grow in the direction of the gradient of activity which is dominant within its region had been noted before the development of the theory of gradients and was given the name *neurobiotaxis*. Kappers, who described this process (1913–1917), and others thought the neuroblasts (neuroepithelial cells) from which neurones develop migrated in the direction of changing dominant nervous impulses. Dr. Coghill (p. 76) believes these writers were describing the same phenomenon which he has here described.

creeps along a surface,] first as a single process going out in only one direction. . . . Later the growing tip near the nucleus spreads in the opposite direction. . . . Eventually the ends also free themselves from the membrane and the cell becomes a neurone. . . . The growing processes of the cell have been forcing their way against the resistance of the indifferent epithelial cells or "doing work." It is analogous to a germinating seed. It is to be regarded as the dynamic unit of the nervous system before it becomes nervous in function.[1]

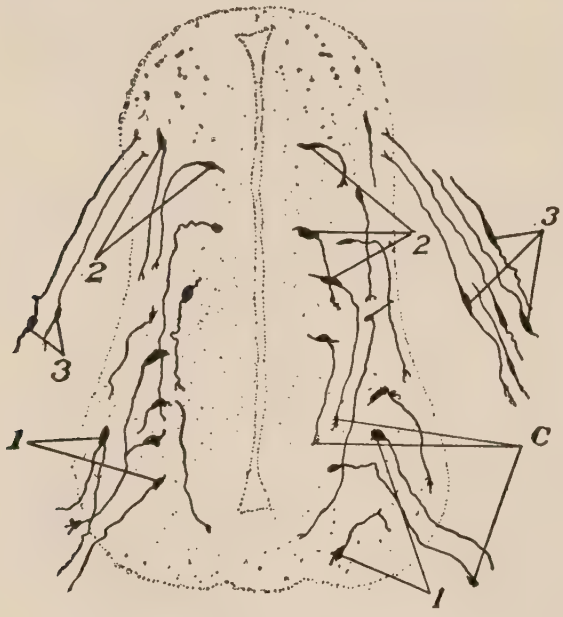


FIG. 97.—Transverse section of spinal cord and spinal ganglia of a three-day chick embyro. 1, motor neuroblasts (embryonic nerve cells); 2, commissural or connecting neuroblasts; 3, ganglionic neuroblasts; *C*, cones of growth or growth tips at ends of growing axones. (*After Wieman, An Introduction to Vertebrate Embryology, McGraw-Hill Book Company, Inc.*)

The sensory cells arise from essentially the same type of primary or neuroepithelial cell as do the motor cells, but these cells are brought under the dominance of the ectodermal gradients which are the major axial gradients; therefore they grow headward and conduct impulses headward instead of tailward, as in the case of the motor cells. However, the lateral branches of the sensory neurone come under the influence of the

[1] COGHILL, *op. cit.*, pp. 53–54. These observations of Dr. Coghill have recently been supported by the reported research of Dr. Carl Caskey Speidel, who studied the developing nervous system of the living tadpole by a special technique. He was able to follow the development of individual nerve fibers in the transparent tail fins of living tadpoles for periods of longer than a month. He says: "The growth cones [the "tips" of Dr. Coghill] travel through the tissues by slow ameboid movement, spinning the nerve fibers behind them. They are quite sensitive to their environment. Exploratory processes are being continually sent out and retracted."

These living, growing nerves sprout from the spinal cord and go directly to the muscle or sense organ they were destined to connect with the central nervous system, according to "some commanding purpose."

The *Science News Letter*, in reporting this, says: "The nerve traveled outward on its important journey much as though it were a whole animal in itself, a sort of very intelligent worm bent on getting where it should go" (*Science News Letter*, Jan. 9, 1932).

mesodermal dominance and grow into the region of high metabolic secondary gradients in the spinal segments along with the motor branches, thus effecting the integration of the two systems. Detwiler[1] cut a segment from the middle portion of the spinal cord of an Amblystoma and reversed it, whereupon it grew and promptly reversed its developmental direction and reintegrated with the rest of the structure. The nerve cells in this segment reversed themselves and followed the order of development of the nerve cells in the other segments, showing that the cells in the transplanted tissue were obedient to the structural gradients of the whole.

It becomes increasingly apparent that *the hereditary pattern wrestles with environment for realization*, and that evolution is "emergent evolution" rising ever to new levels. We have now seen that this is true of the general physical structures and also of the structures destined to culminate in the organ of thought, the brain.

The Vertebrate Nervous Mechanism.—We have seen that protoplasm, the mother-substance of life, is sensitive to impressions and that it can react to these without losing its identity or changing its basic form or character. We have seen especially sensitized streams of protoplasm appear out of the homogeneous matrix like "quantities upon a ground."[2] We have seen these streams become complex, forming nerve nets with impulses running in all directions. We have seen centers of dominance appear within this primitive mechanism such that impulses begin to be directed in specific directions with gradations of intensity.

In the earthworm we saw further elaboration, with the appearance of a primitive brain, nerve-cord, and reflex nerve arcs, these arcs consisting of sensory, motor, and communicating nerve cells connected in chain-like fashion by their nerve processes. In Amblystoma we saw something of the manner in which these structures develop from the basic protoplasm. We shall now consider in some detail the mechanism of these structures.

[1] Detwiler, S. R., Experiments on the Reversal of the Spinal Cord in Amblystoma Embryo, *Journal of Experimental Zoology*, vol. 38, pp. 293–321, 1923.

[2] This expression occurs frequently in the literature of Gestalt psychology, and refers to the abrupt appearance of "patterned" behavior responses.

Neurons.—Neurone (or neuron) is the name applied to a nerve cell, together with all of its branches, processes, and fibers. We have seen a simple nerve cell (Fig. 96) arise within embryonic homogeneous tissue. We saw that branches extend from this cell in two directions, toward the tail and toward the head, and these processes may also send out lateral or sidewise branches. The one long conducting process is called an *axone*, the many short receiving processes are called *dendrites*. The cell structure itself consists of the nucleus and cytoplasm typical of all functioning cells (see page 42).

Axones.—The axone (axon) (also called the nerve, nerve fiber, or the axis-cylinder) consists of bundles of conducting fibers (*neurofibrils*) of microscopic size. The axones are surrounded or encased in a layer of fatty nutritive tissue called the *myelin* or *medullary sheath*. This sheath in the long nerves is segmented at intervals, and is in turn covered by a layer of protective or insulating multinucleated substance called the *neurilemma*. It is these which give medullated nerves and nerve trunks their white appearance. The autonomic ("sympathetic") nonmedullated nerve fibers (see page 436) are not enclosed in a myelin sheath and are gray in color.

Neurofibrils.—About the time that developing nerve cells begin to function, minute threads of denser material appear within the protoplasm of the cell and its branches. These appear to be continuous throughout these structures (see Fig. 98 *a*) and are thought to be the real conductors of the nerve impulse. There is no absolutely conclusive evidence as to the composition and function of these fibrils. However, we are bound to believe that they were foreshadowed by the sensitive protoplasmic stream in vorticella and the nerve net in medusa. These neurofibrils are massed to form the axone (axis-cylinder) of the neurone. They end in the specialized motor and sensory *nerve plates* or *end organs*, or in *free endings*.

Dendrites are, actually, extensions of nerve-cell cytoplasm corresponding to the pseudopodia of the ameba, and the cilia of paramecium, but the dendrites are structurally fixed in the cell, thus enormously increasing the avenues of "experience" for the cell. The word dendrite means "tree-like." The dendrite branches assume many forms, and may become exceed-

ingly complex, especially in the association or communicating cells of the cortices of the cerebrum and of the cerebellum (see Fig. 106). It is believed by some that the numberless points of contact (association) in the cerebrum may keep on multiplying, and that this may enter into the process of maturation and the

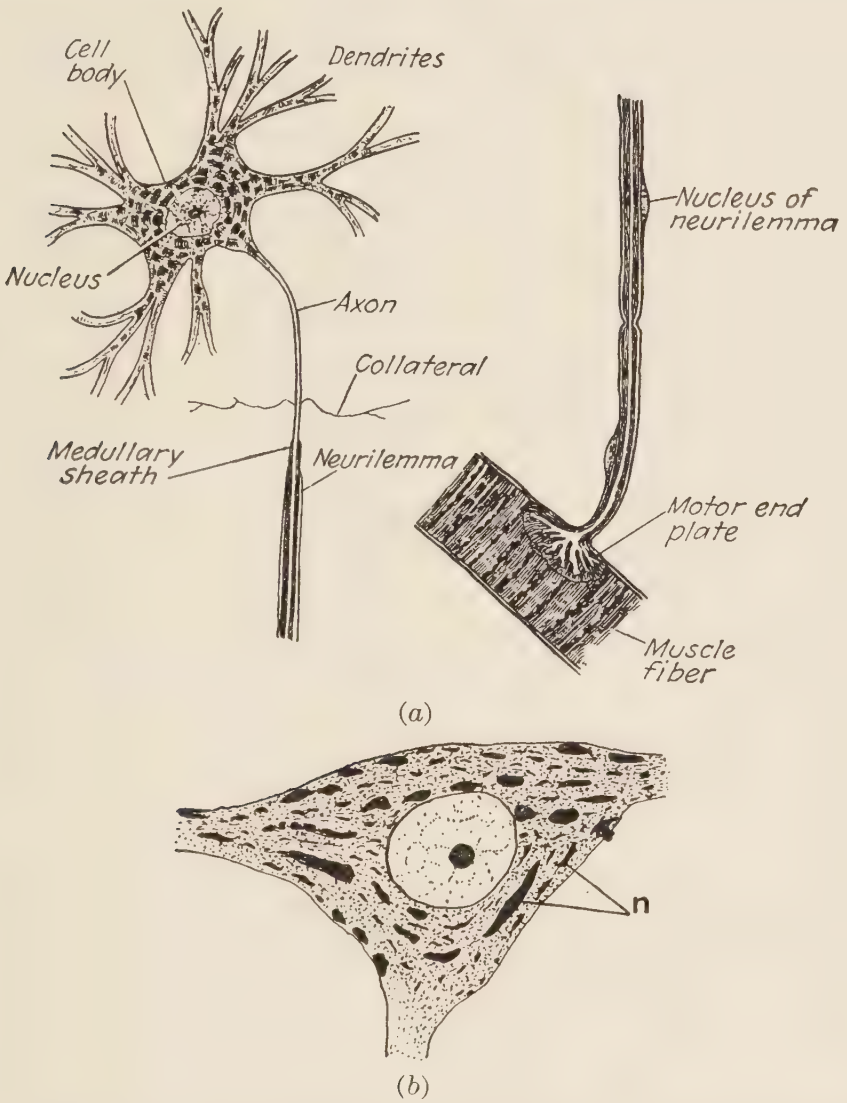


FIG. 98.—(*a*) Nerve cell showing axone, dendrites, medullary sheath, neurilemma, and ending. (*After Wolcott.*) (*b*) Nerve cell showing axone, dendrites, and Nissl bodies. The neurofibrils ramify among the Nissl bodies but are not shown in the picture. (*After Wieman.*)

development of reasoning (learning) during the entire life of the individual, as well as during early growth. One cannot help thinking of these in terms of fixed gradients of metabolic and electrical activity.

Nissl Bodies.—Soon after the neurofibrils appear within the cytoplasm of the cell and its branches, irregular, darkly staining

masses of chromophilic (chromatin-like) substance appear within the cell body and sometimes appear within the larger dendrites, but never within the axone. These are called *Nissl bodies* (Fig. 98, *b*). They are made up of nucleoprotein containing iron and other minerals, and seem to be important in the metabolism of the cell. This substance disappears during fatigue and reappears on rest. In certain pathological conditions it is also deficient.

While the exact character and function of Nissl bodies are still not clear, it has been noted that different kinds of nerve cells show characteristic variations in the size and appearance of these masses. Sensory cells show finely granular and evenly distributed Nissl bodies, while in motor cells they appear in coarser masses. It is said that the Nissl bodies in the motor neurones of the viscera, which are under the regulation of the autonomic (sympathetic) nervous system and are slow in action, are smaller and stain less deeply than do the motor cells supplying the rapidly acting striated muscle. The inference is that the Nissl bodies are stores of fuel and proteins in form easily available to the cell engine.

End Organs.—The nerve substance is most economically distributed in the neurone, with a maximum surface of contact and transmission provided by the branching axone and dendrites. This efficiency is further multiplied by having the ends of dendrite and axone fibers ramify in expansions which increase the range of influence of the central nerve cell. The motor nerve fibers terminate in end-plates in direct contact with muscle fibers (Fig. 98 *a*, also Fig. 99). The dendrites end in a great variety of sensory mechanisms, some of which are supposed to be adapted for conveying one kind of sensation only. These include free nerve-endings for pain, and possibly special nerve-endings for heat and cold, pressure, etc., although this is not entirely clear. In close association with the sensory dendrites are the specialized receptor organs of sight, hearing, smell, taste, and equilibrium.

The Synapse.—While impulses normally pass in one direction only in a given neurone, strong excitation applied midway on a nerve trunk will be transmitted in both directions to the ends of the neurofibrils. Where this neurone comes in contact with another neurone through its processes the excitation cannot be made to pass contrary to its normal direction. There is a barrier

between neurones where their respective processes come in contact with each other which acts as does a valve in a tube which will not permit fluid to flow backward. This barrier is called the *synapse* (see Fig. 102). The synapse consists in some alteration of the protoplasm the nature of which is not understood. The exact rôle of the synapse in nervous and mental activity is not known but has given rise to much speculation. Obviously

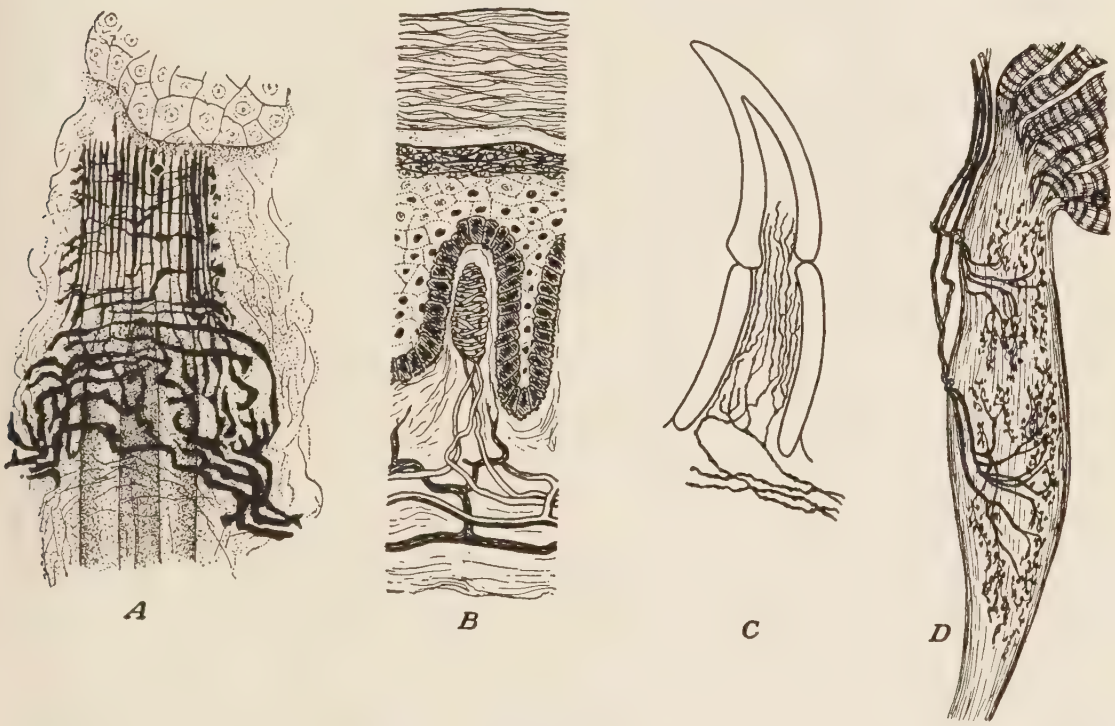


FIG. 99.—Varieties of nerve terminations. *A*, nerve endings about a large hair from a dog. (*Herrick after Bonnet.*) *B*, a nervous papilla from human skin. (*Herrick after Cunningham.*) *C*, nerve terminals in tooth of a fish. (*Herrick after Retzins.*) *D*, sensory nerve ending from muscle of a rabbit. (*Herrick after Huber and DeWitt.*) (*Modified from Herrick, Introduction to Neurology, W. B. Saunders Company.*)

such a specialized mechanism as this must have an important function. The psychologists who believe that the reflex arc is the all-important thing in the mechanism of behavior, and also the "associationists," ascribe a great deal of importance to the rôle of the synapse in the direction and determination of association paths.

Recently there is questioning of the soundness of the association doctrine and along with this a shift of opinion as to the significance of the synapse.

Lashley says:

The surface membranes separating the neurons have been most stressed in theories of the mechanism of integration, since they form the only known break in continuity of fibers where diffuse conduction seems likely to occur. The fundamental importance of the synapse seems a logical conclusion, yet we must bear in mind when evaluating theories of learning that the properties of the synapse are still entirely hypothetical. If we deduce its properties from the facts of learning, we gain nothing by explaining learning in terms of these hypothetical properties.[1]

In brief terms, the synapse must be studied further before its structure and function are understood, and we cannot, at present, be certain of its rôle in behavior.

The Rise of the Brain.—Dr. Coghill has shown us very graphically how the motor and sensory nerve cells of Amblystoma arise in obedience to accelerated chemical activity in the physiological gradients. We shall presently see that these develop far in advance of their function. Correlated actions (reflexes) between them become possible when the commissural or connecting cells form within the spinal cord (see Fig. 96). He also watched the development of the brain by the same precise and carefully controlled methods, and tells us that centers of rapid differentiation appear at the anterior end of the embryo. The center of acceleration of the sensory system

apparently enters into a reciprocal activity with the center of acceleration of the motor system in such a way that the two centers approach each other and come to occupy the same level in the nervous system. However, this shifting of position in the centers is not brought about by migration of cells [as was thought by Kappers and others]. It is accomplished by a shifting of the center of highest rate of differentiation.[2]

Three centers of acceleration (gradients) make their appearance almost simultaneously during the very early nonmotile stage of Amblystoma, each controlling the development of a respective part of the forebrain. Then:

centers of differentiation in the brain and spinal cord arise as centers of disturbance in a placid lake. The disturbance, however, is of greater

[1] *Foundations of Experimental Psychology*, chap. XIV, by K. S. Lashley, p. 541, Nervous Mechanisms in Learning, Clark University Press, 1929.

[2] Coghill, *op. cit.*, p. 65.

intensity or amplitude in some centers than in others. This difference appears to be correlated with the orientation of neurones and the growth of conduction paths.[1]

It would be of interest to follow Nature as she has tried out one form of mechanism after another for the initiation and control of living behavior. A glance at the tree of life (Fig. 3) will stimulate the imagination to a fruitless effort to conceive the endless variety of experiment and the slow accumulation of improvements of technique and mechanism. Enough has been said to show that the progression has been continuous from the circumscribed protoplasmic stream of vorticella, the nerve net of medusa, the nerve ring of the starfish, the reflex ladder and ganglionic brain of the earthworm, to the hindbrain-midbrain-forebrain of the frog, toad, fish, ape, and man.

The illuminating thing about it all is the fact that Nature, master workman that she is, has accomplished all this with but one tool—and she has so to speak, a patent on this—the *physiological gradient;* she has evolved her patterns through the single agency of the *gene;* and her raw materials were the *elements of the earth!*

In General.—The essential structural unit of the nervous system is the protoplasmic cell with its axone and dendrites, the entire structure constituting a neurone. This originally simple unitary structure, however, becomes complicated and assumes many different forms before it culminates in a human brain and nervous system.

That there are essential metabolic and chemical differences between various types of nerve cells is shown by the fact that certain substances are toxic to sensory neurones and not to motor neurones and *vice versa.*

Dendrites tend to be numerous, short, and branching, while the one axone with which each cell is provided may be exceedingly long, as in the instance of the axones of the motor and sensory cells which reach from the feet to the spinal cord.

The protoplasm of the dendrites is similar to that of the cell body, and may contain chromophilic masses (Nissl bodies). The protoplasm of the cell body is adapted to the carrying on of

[1] *Ibid.*, pp. 68–70.

intensive metabolic processes, as is evidenced by the presence of accessory nucleoprotein in the chromophilic Nissl bodies in addition to the nucleoprotein of the nucleus.

The structure of the axone seems especially adapted to transmit the impulse which has been elaborated within the cell. The neurofibrils are massed to form the neurone (axis-cylinder or nerve). These fibrils are embedded in a jelly-like neuroplasm and the axis-cylinder itself is usually surrounded by the protoplasmic myelin sheath and neurilemma which are supposed to act in the rôle of nutritive mechanism and insulator respectively. While the cell body becomes fatigued and uses up its definite energy potential and must be renewed by rest and food, the axone with its neurofibrils is believed from numerous experiments to be indefatigable. In other words, the battery may run down or wear out but the transmission wires never lose their full conductivity while they are intact.

Child and others assert that each neurone by itself, and the reflex arc as a whole, have gradients in the sense that metabolism is highest at the receptive end and lowest at the discharging end of the circuit. This general polarization is determined at the time of the development of the cell by the physiological gradient of the matrix within which it appears.

These mechanisms are obviously evolved for the single purpose of serving a central mechanism of control or direction, the brain. The brain rises out of the developmental matrix in shadowy form at first, but assumes elaborate "qualities" as evolution proceeds, until the major achievement up to the present time, the human brain, appears. The further purpose of the cosmic plan is not for us to know.

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CHAPTER XXV

THE BRAIN

The Brain Is Wider than the Sky

The brain is wider than the sky,
For, put them side by side,
The one the other will include
With ease, and you beside.

The brain is deeper than the sea,
For, hold them, blue to blue,
The one the other will absorb,
As sponges, buckets do.

The brain is just the weight of God,
For, lift them, pound for pound,
And they will differ, if they do,
As syllable from sound.

EMILY DICKINSON[1]

A Dual Control.—One factor which complicates the dynamics of the human body is the fact that two mechanisms of control are involved: one that regulates the body itself, keeps it working as an organism, with its parts adjusted and in running order; and one that directs its relations with the outside world. These, sometimes called the "old" and the "new" brains with their related and tributary systems of nervous mechanisms, bear somewhat the relation to each other of fireman (the "old" brain) and engineer (the "new" brain) in running a train, or mechanic and pilot on an airplane. As there must be close understanding between these operators, and constant, flexible communication, so must there be close intercommunication between the physiological control and the mental control of the body. Further, it is the pilot and the engineer who do the worrying and have the responsibility of choice; their assistants quite automatically see to the fuel and the oil and obey orders. The less emotion assist-

[1] From *The Poems of Emily Dickinson,* Centenary ed., edited by Martha Dickinson Bianchi and Alfred Leete Hampson, reprinted by permission of Little, Brown & Company.

ants have about the matter the better they do their work and the better they serve their directors.

The Autonomic (Vegetative) Nervous System.—So we find in the human body a mechanism which is almost completely separated from sensory influence or conscious control. This is the autonomic (automatic) system, sometimes called the "sympathetic" system, although this term is more correctly applied to one part only of the mechanism. It is also called the "vegetative" nervous system. The autonomic system is a primitive nervous mechanism consisting primarily of numerous ganglia having motor neurones communicating with all the vital organs, the circulatory system, and with almost all parts and structures of the body. This mechanism connects very directly with the "old" parts of the brain, which antedate the cerebrum in origin, and which operate below the level of cerebral consciousness, although, as we shall see, the autonomic system is affected by cerebral states and *vice versa*.[1] The medulla of the adrenal glands, and the carotid body (a glandular mass lying upon the carotid artery about which little is known) seem to arise from the same preneural matrix as the autonomic nerve cells. The adrenal medulla is known to be closely associated with the autonomic nervous system in function as well as in origin and structure; indeed, it is sometimes called "the brain of the vegetative system" (see page 112, chap. VII).

The outstanding structural feature of the autonomic system is a ladder of ganglia on either side of the spinal column. These ganglia are connected with each other, with the spinal cord, and with the vital organs, blood vessels, and organs of special sense, and, indirectly, *with both the "old" and the "new" brains* (see Fig. 101).

The general plan of operation of the autonomic system is as follows: The axone of a medullated (white) sensory neurone in the spinal cord or lower brain connects by synapse with the

[1] "Those phases of his [man's] behavior which take place through the functioning of the 'old' brain alone, without any cooperation of the cortex, appear to be unconscious. Since the 'old' brain gives rise to no experiences, man knows as little by way of it as he does of what is happening on the moon" (KOFFKA, KURT, *The Growth of the Mind*, p. 23, Harcourt, Brace & Company, 1927).

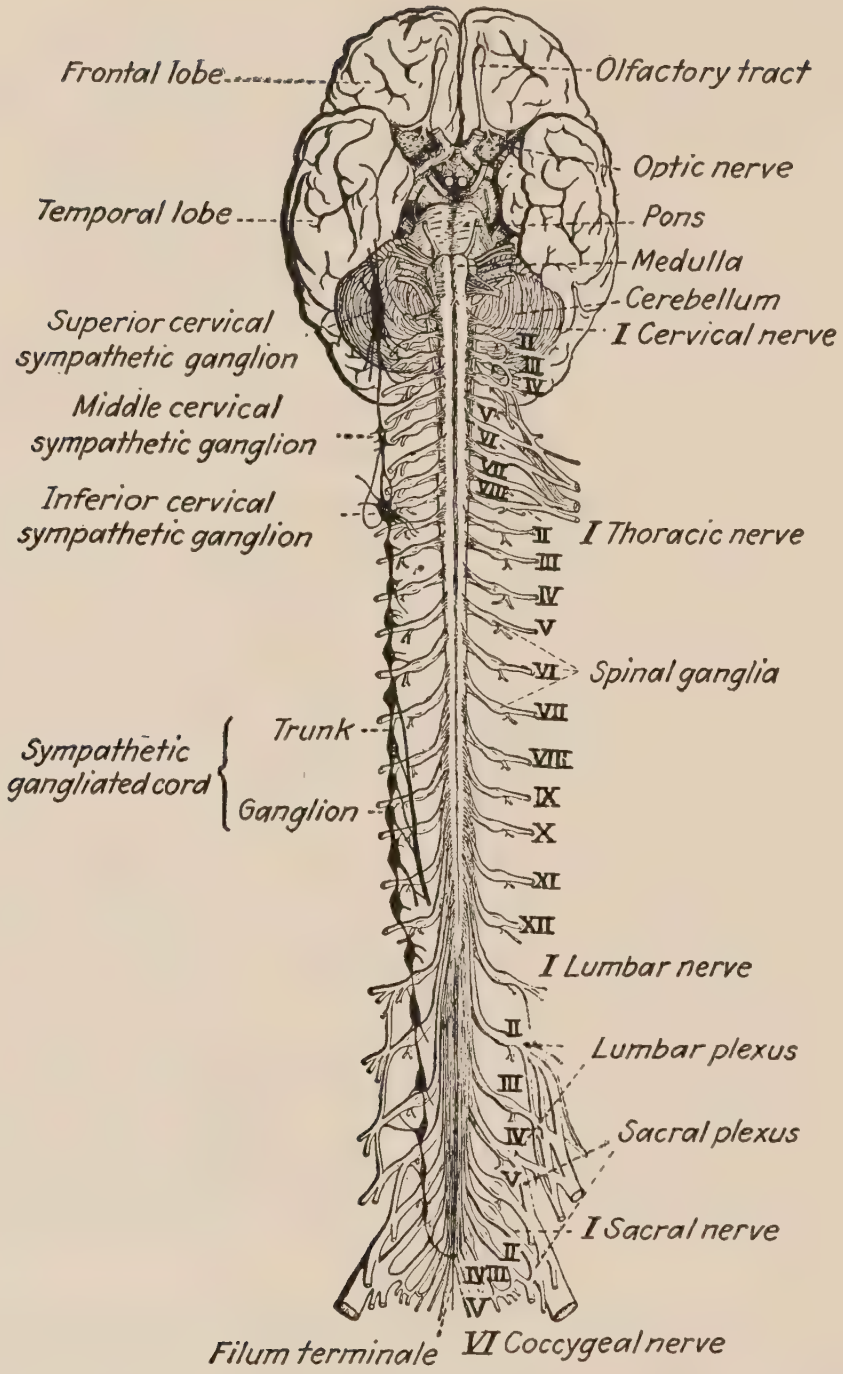


FIG. 100.—The human central nervous system, from the front, showing its connection with the cerebro-spinal nerves and with the sympathetic nervous system (drawn in black on the left). *(From Herrick after Allen, Thompson and Rauber, Introduction to Neurology, W. B. Saunders Company.)*

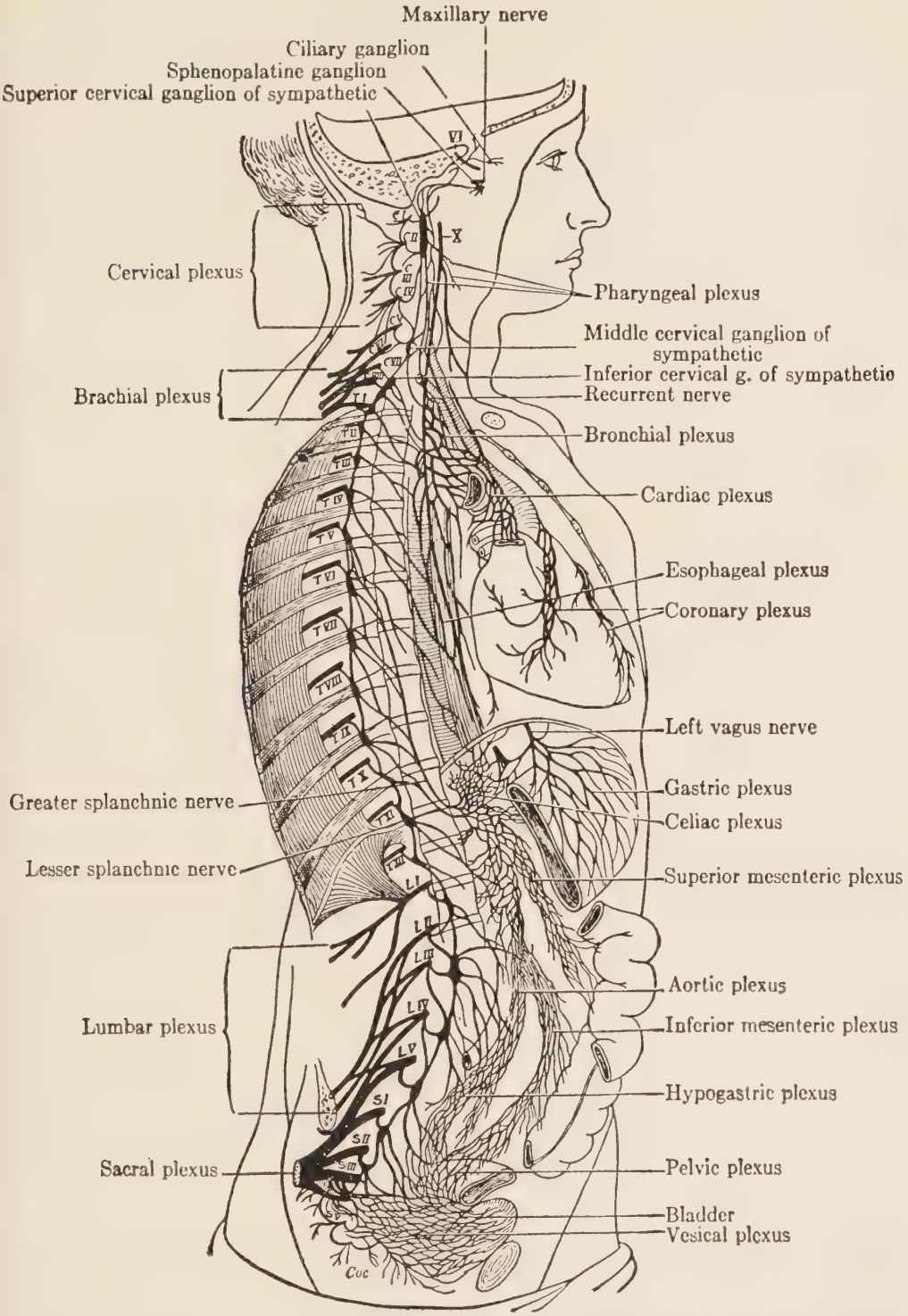


FIG. 101.—The autonomic (sympathetic) nervous system showing right sympathetic trunk, spinal nerves, and sympathetic ganglionated plexuses. (*Herrick after Schwalbe, Introduction to Neurology, W. B. Saunders Company.*)

dendrites of a motor neurone within an autonomic ganglion, which then sends a message over a nonmedullated (gray) axone to some gland, organ, or part involved in the physiological functioning of the body.[1]

The autonomic nerve system carries impulses to glands and to the muscles of the physiological organs of the body, such as the unstriped (smooth), slow-acting muscles in the walls of the blood vessels, intestines, stomach, the iris of the eye, the base of the hairs of the skin, etc.

Marvelous adjustment of the activity of the body organs is achieved by this self-regulating mechanism, working entirely below the level of consciousness in a state of health and even in some conditions of disorder or imbalance of the organic machinery. This is the reason we are not ordinarily conscious of digestion, circulation, breathing, or any of the tremendous chemical activity which is going on constantly during life.

The action of the autonomic system upon organic function is accomplished partly by direct stimulation from the ganglionic neurones[2] which receive their stimulus in turn from many sources (including indirectly the cerebrum) and partly through its control of the blood supply of the particular organ through adaptive stimulation of the vaso-constrictor and vaso-dilator autonomic nerves in the blood-vessel walls.

The delicate and rapid response of the glands of internal secretion, particularly the adrenals and thyroid, is dependent largely upon the autonomic system. Blushing, the sweat and goose flesh of fear, faintness, nausea, etc., are in part at least due to the subconscious reaction of the autonomic system to the situation reported to it from the cerebro-spinal system. "The stimulus is received in some ganglion, or some center in the spinal cord,

[1] Franz, Shepherd Ivory and Kate Gordon, *Psychology*, pp. 257–259 Sympathetic Nervous System, McGraw-Hill Book Company, Inc., 1933.

[2] It is possible to trace many of these autonomic paths by the use of nicotine. This active substance of tobacco is painted on or injected into an exposed ganglion. Then, if the preganglionic (spinal nerve) fiber is stimulated, no response occurs along its path. If, however, the postganglionic fiber is stimulated, a response is made. Evidently, therefore, nicotine paralyzes the synaptic connection between the two neurones in the path" (Caldwell, Skinner, and Tietz, *Biological Foundations of Education*, p. 165, Ginn & Company, 1931).

medulla, or midbrain. The response is made before we are aware of the stimulus. These actions are therefore called reflexes."[1]

The Cerebro-spinal Nervous System. *The Reflex Arc.*—We have seen that the primitive nervous system of the earthworm consists of chains of reflex segments having a simple rudimentary coordinating brain (see Fig. 94). Out of this mechanical device Nature has manufactured the most complicated and delicately adjusted mechanism in the known universe—the human brain and nervous system. A reflex arc is any complete pathway between a sensory and a motor neurone over which action takes

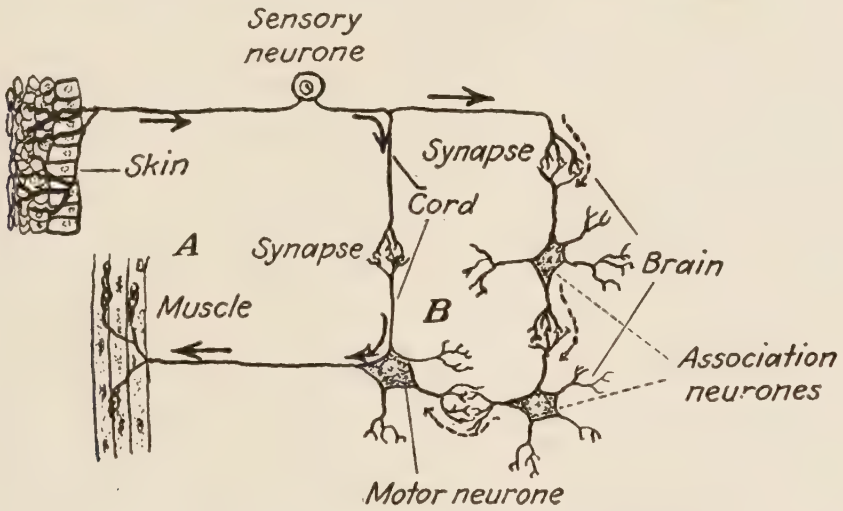


FIG. 102.—Reflex arcs. *A* simple reflex through the spinal cord; *B*, the same impulse continued through the association mechanism of the brain after the muscle has been stimulated. (*Modified from Kirkpatrick-Huettner by permission of Ginn & Company.*)

place below the level of cortical or conscious control. The simplest example is a two-neurone circuit through the spinal cord as illustrated in Fig. 102. A slightly more complex type is represented when a commissural (communicating) neurone in the cord transfers the sensory (afferent) stimulus to the opposite side of the cord (and of the body) or to a higher or lower level of the cord, and stimulates a motor (efferent) neurone, on the opposite side or another part, to action. The sensory stimulus may be relayed over a variable number of communicating neurones to the medulla or midbrain before it reaches completion in action through some efferent motor neurone, and, as we have just seen, the autonomic nervous system is involved in much of the reflex activity of the body mechanism (Fig. 100).

[1] CALDWELL, SKINNER, and TIETZ, *op. cit.*, p. 173.

Ganglion is the term used to designate a group of nerve cells which acts as a relay station or "transformer." Ganglia are found here and there throughout the body. Frequent mention is made of these in discussion of various nerve units. In addition to the autonomic ganglia there are ganglia on the posterior spinal nerve roots which contain blood and lymph vessels, as well as neurones, and are supposed to serve a nutritive function to the sensory nerves entering the spinal cord. The efferent and afferent nerves passing through the spinal ganglia join, after leaving the ganglion, to form the spinal nerves. Fibers from the spinal nerves enter the autonomic ganglia which have been described (Figs. 100 and 101).

Plexuses.—A *plexus* is a web or net of nerves. Plexuses are found in various parts of the nervous system, some of them in direct connection with the sympathetic system. Several, such as the cervical, brachial, and sacral plexuses, seem to distribute the cerebro-spinal nerves more effectively in the shoulder, arm, pelvis, and leg. In the intestines and in the heart are found several very primitive nerve nets the function of which is not known. The sympathetic ganglia of the trunk communicate with a sizable plexus known as the *solar plexus* from which radiate fibers to the diaphragm, spleen, liver, stomach, kidneys, aorta, heart, pancreas, intestines, and pelvic organs. The disastrous effect of a "blow on the solar plexus" can readily be understood.

The Spinal Cord.—Very simply stated, the spinal nerve cord is the grand trunk cable of communication between brain and body. It is slightly less than ½ inch in diameter, about 18 inches long, and ends just below the attachment of the lower ribs to the spine. It has 31 pairs of branching nerves which are distributed to the body below the head. It originated, as we have seen (page 36), from the ectoderm or outside embryonic layer which infolded to form a tube, and it eventually became surrounded by the mesoderm or middle layer from which the segmented vertebrate spine formed with openings between the vertebrae for outgoing nerves.

The cord itself is composed of an inner mass of gray cells surrounded by white nerve fibers or axones. These are arranged in two equal-sized lateral halves with a connecting band. In cut section the gray mass is butterfly shaped (Fig. 103). Some

of the cells in the anterior (ventral or motor) areas act in conjunction with incoming sensory neurones in the posterior or sensory areas, to complete the spinal reflex; some of them act as communicating cells between the two halves of the cord; some serve to connect the cord with the sympathetic ganglia, while many others serve as relays in sending messages to and from the body and the brain.

The spinal nerve system is often likened to the wires of a telephone system with its cables, branches, and receivers (corresponding to nerve end-organs). In the telephone wire, however, the current flows both ways, as in the primitive nerve net, while in the nerves there are separate fibers (often in the same sheath) for afferent (ingoing) and efferent (outgoing) nerve currents.

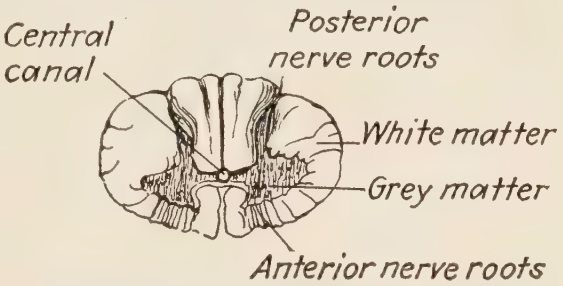


FIG. 103.—A cross section of the spinal cord.

This spinal-nerve cable is a further illustration of concentrated potency. It contains within its circular $\frac{4}{10}$ inch a central core of nerve cells occupying at least half of the given space. The gray core is surrounded with a literally incalculable number of millions of microscopic nerve fibers, long and short, which serve to make the complicated integrations between every cell in the organs and members of the body and the brain. And the entire cord, exclusive of enveloping membranes, weighs slightly more than 1 ounce![1]

The Meninges.—The spinal nerve cord and the brain are covered with three protective membranes, the *meninges.* Between the two inner layers is a quantity of spinal fluid which serves as a protecting buffer or cushion to equalize pressure about the cord (there is also a small central canal in the cord continuous with the ventricles of the brain). *The spinal fluid* has a very constant chemical composition and is supposed to have some nutritive function. In certain diseases affecting the brain and cord this chemical composition is altered. By drawing off some of this fluid by "spinal puncture" and making chemical analysis valuable diagnostic information is sometimes secured.

[1] CALDWELL, SKINNER, and TIETZ, *op. cit.*, p. 154.

The brain is the most remarkable living structure yet accomplished in evolution. A few of the steps in the evolution of the brain and of the behaving mechanism have been sketched. A further brief description of the brain is here presented for the purpose of bringing before us, somewhat graphically, at least a faint concept of what actually takes place when a child "behaves."

The *autonomic* functions of the behaving mechanism are centralized or correlated through the agency of the "old" structures of the brain, structures common to all vertebrates.[1] The

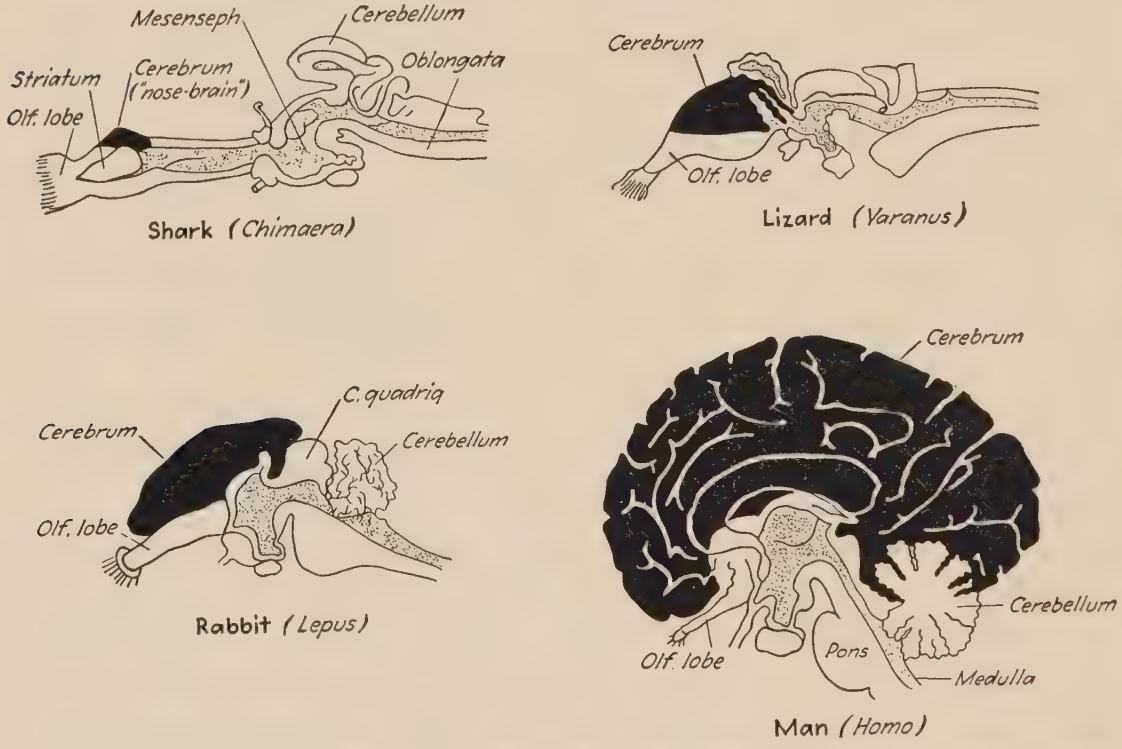


FIG. 104.—The evolution of the cerebrum (new brain). (*Adapted from Koffka after Edinger.*)

"new" brain, the *cerebrum* with its *cortex*, first appears in very rudimentary form, as the "nose" brain in the shark or dog fish, and is little more than an extension of the sensory organs. From the bony fishes on, the cerebrum increases in size and importance until in man it entirely overshadows the old brain in bulk and constitutes about half of the total brain weight.

The old brain takes care of all simple reflexes, some conditioned reflexes, and certain forms of simple "biological learning" can be carried on without the aid of the new brain. All of these responses are carried on below the level of consciousness. That

[1] KOFFKA, *op. cit.*, pp. 23–25.

even the old brain is a complex mechanism will be apparent from a mere enumeration of some of its structures and their functions.

The old brain begins with the expansion of the upper end of the spinal cord called the *medulla oblongata*, (*myelencephalon*) or *spinal bulb.* The medulla contains certain neurones which cooperate with the autonomic ganglia; it also contains bundles of conducting fibers known as the *pyramids* which form the chief avenues of communication between body and brain. The pyramidal fibers cross in such a way that the right side of the

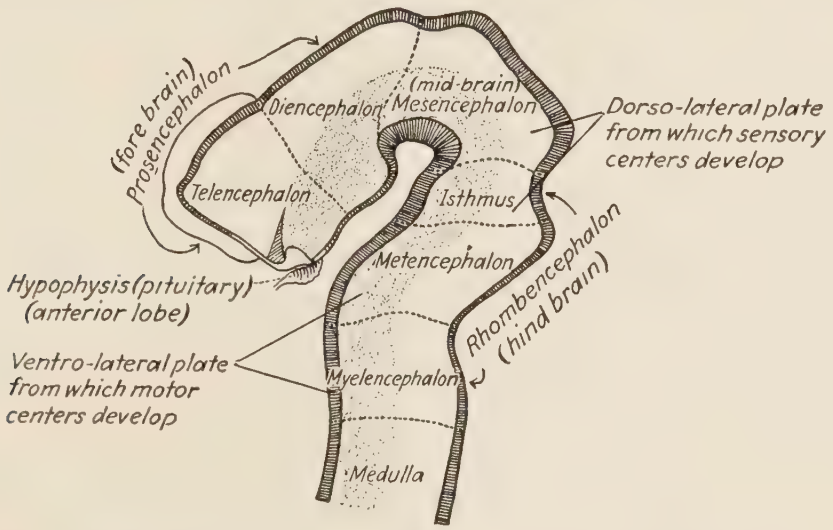


FIG. 105.—Diagram of the inner surface of a developing brain in a human embryo of about four weeks. (*From Herrick, Introduction to Neurology, W. B. Saunders Company.*)

brain chiefly controls the left side of the body and *vice versa*, a curious arrangement the reason for which is not known.

Above the medulla is the *pons* or "bridge" (*metencephalon*) consisting of nerve fibers which establish cross connection between the cerebrum and the cerebellum and make possible the finely coordinated muscular movements of the body such as are involved in writing, musical performance, technical skills, etc.[1]

The *cerebellum "little brain"* (*also part of the metencephalon*), lies above and somewhat behind the medulla and pons. Between the cerebellum and the lower structures is an open space known as the *fourth ventricle* which contains cerebro-spinal fluid and

[1] WHEELER, R. H., *Principles of Mental Development*, chaps. III and IV, especially pp. 60–62, Thomas Y. Crowell Company, 1932; KOFFKA, *op. cit.*, chap. I, Consciousness and the New System.

communicates with the three other ventricles of the brain and with the central canal of the spinal cord.

The cerebellum is relatively large in active animals, such as swim, fly, or run, and small in short-legged or mud-dwelling vertebrates. In man the cerebellum constitutes about one-tenth of the total brain weight. The cerebellum consists of two wing-shaped lobes which have their surfaces enormously increased by the familiar device of Nature of wrinkling a surface into folds. The gray cells are on the surface, the fibers or axones (white) on the inside. A cut section of a cerebellar lobe has a characteristic tree-like appearance to which the term "arbor vitae" (tree of life) was applied by early anatomists (Fig. 27).

As was said above, the function of the cerebellum seems chiefly to be that of motor coordination.

> The fundamental function of the cerebellum is the coordination of separate movements into the complexes necessary for the performance of special acts (synergia). . . . This synergic control seems to be effected in essentially the same way whether the movements are called forth reflexly or voluntarily.[1]
>
> The cerebellum must be regarded as an essential part of this mechanism whose probable function it is to determine the rate of flow of excitor and inhibitor impulses into the various groups of muscles brought into action through its underlying reflex mechanism.[2]

Not an inconsiderable part of the cerebellar function is the maintenance of general muscle "tone" or balance, and the regulation of body equilibrium and posture. In the animal which must maintain his upright posture in opposition to natural forces of gravity, this muscle tone and postural balance are both complicated and important.

> In order to bring about this elaborate coordination to maintain correct position a constant checking up, or an adjustment to a large number of incoming sensory impulses, is necessary. Therefore we have the large bundles of fibers connecting the cerebellum with other parts of the central nervous system [see pons]. Fibers from the portion of the brain receiving impulses from the eye, from the balancing organs of the

[1] Herrick, C. J., *Introduction to Neurology*, p. 213, W. B. Saunders Company, 1922.

[2] Papez, J. W., The Human Brain, *Eugenics*, October, 1930.

labyrinth in the ear, from the medulla, and from the spinal cord to the motor nuclei of the eye muscles are connected with the cerebellum.[1]

The cerebellum is not ready for function at birth, hence the inability of the infant to coordinate any of his muscles. It seems probable that the ability to walk and the urge to walk mark the functional maturation of the cerebellum.[2]

The gray cortex of the cerebellum is composed of several layers of cells. Those of the greatest evident importance are the

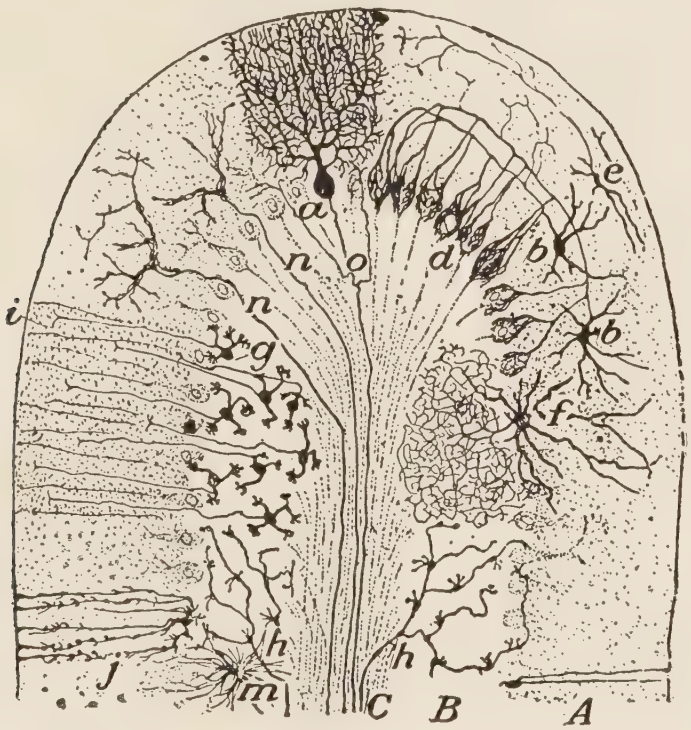


Fig. 106.—Diagram of the various cells found in one fold of cerebellum. *a*, a Purkinje cell. (*After Ramón y Cajal, from "Histology," by permission of William Wood & Company.*)

Purkinje cells. The latter (Cell *a*, Fig. 106) have excessively branched dendrites, making an incalculable number of contacts possible for each cell. The outgoing axone goes more or less directly to a specific muscle. It is thought by some neurologists that the cerebellum may be definitely mapped according to these regions of specific control.[3]

The Purkinje cells, in common with other central nerve cells, show marked changes in exhaustion from extreme physical exertion, insomnia, or other unfavorable conditions. The chromatic

[1] Caldwell, Skinner, and Tietz, *op. cit.*, p. 143.

[2] Koffka, Kurt, *op. cit.*, p. 59.

[3] Herrick, C. J., *Introduction to Neurology*, p. 211.

material in the Nissl bodies fades and the cell becomes shrunken (crenated, see Fig. 107).[1]

The Innerbrain.—Between the cerebellum and the forebrain, and all but covered by the overhanging masses of the forebrain, we find two small structures, the *midbrain* (mesencephalon)



(*a*) (*b*)

Fig. 107.—Photomicrographs showing effect of fright on the brain cells of a rabbit. (*a*) Normal section of cerebellum of a rabbit; (*b*) Section of the cerebellum of a rabbit after extreme fright. Note the almost complete disappearance of the Purkinje cells in *b*. (*From Crile, Man—An Adaptive Mechanism, The Macmillan Company.*)

and the *interbrain* (diencephalon) which together form what is sometimes called the *innerbrain.* The midbrain consists of groups of very primitive ganglia, the least changed from the embryonic stage of any part of the brain. It even retains in its interior an open space left from the original neural tube called the Aqueduct of Sylvius which opening connects the lateral

[1] Crile, G. W., *Man—An Adaptive Mechanism,* The Macmillan Company, 1916.

ventricles with the third ventricle. From the roof of the aqueduct two pairs of cranial nerves arise (the III and IV) which activate the muscles of the eyeballs. Other parts send fibers to the ear and the skin of the facial region. It also furnishes a highway for the nerve fibers passing from the cerebrum to the cord. *The interbrain or endbrain* lies at the base of the cerebral hemispheres and connects these with each other and with the other structures which have been named.

The Cranial Nerves.—Twelve pairs of nerves arise from various parts of the brain structures, corresponding to, perhaps we might say they are continuations of, the series of 31 pairs of spinal nerves. The cranial nerves chiefly innervate the special sense organs and the muscles of the head. The first pair, the olfactory nerves, and the second, the optic nerves, are really extensions of brain substance, the "nose brain," of the bony fish (see page 440). The cortex actually arose from the enlargement of these sensory centers.

The Vagus or Pneumogastric (Wandering, "Vagrant") Nerve.—The tenth pair of cranial nerves arise from the medulla and these nerves are unique in function and importance. The vagus nerves are both sensory and motor in function, receiving sensory neurones from the tongue, pharynx, oesophagus, liver, stomach, and lungs and in return sending motor fibers to these organs, and thus integrating with the autonomic nerve system in regulating the activity of all the visceral organs. These nerves have a wide range of action and are involved in most of the physiological activities of the body. They operate below the level of consciousness.

The particular functions of the remaining cranial nerves will be found described in any text on the anatomy or physiology of the brain.

The New Brain.—*The cerebrum, "forebrain" (prosencephalon)*, is Nature's master-piece up to the present time—the "thinking machine." The cerebrum first appears in fishes as an olfactory lobe ("nose brain") with a mere "prophecy" of a cortex. The dominance of the cerebrum with its cortex over all other parts of the brain comes slowly from fishes to mammals. In mammals the cerebrum rapidly overshadows the other brain structures and in man it has taken on enormous importance (Fig. 104).

Fishes and amphibians have no well-defined cortex; reptiles and birds possess a clearly defined cortex though limited in amount and of very primitive structure. In the mammals the cortex is suddenly expanded in amount and elaborated in internal texture even in the lowest mammals, while in man "the association centers of his cortex are magnified and in internal texture complicated in measure commensurate with his enlarged and glorified mental powers."[1]

Herrick says:

> Throughout this series of progressively more complicated cortical patterns no fundamentally new structural features are added. The most highly elaborated cortex is made up of neurones of substantially the same sort as those of the rest of the brain. Anatomically, this progressive evolution appears to be wholly a matter of increase in number of neurones and gradual change in the structural arrangements by which they are physiologically interconnected.[2]

The cerebrum is divided into two longitudinal hemispheres having their surface deeply wrinkled into convolutions, fissures, and lobes. When the skull is opened the cerebral portion of the brain somewhat resembles the kernel of an English walnut. If the two hemispheres are pulled apart they are found to be joined at their bases by a dense mass of intercommunicating fibers called the *corpus callosum* (part of innerbrain).

If cut across vertically each hemisphere is found to contain a hollow space communicating with the other ventricles. These are the *lateral ventricles.*

The Cortex, "New Mantle" (Neopallium).—The essential element of the cerebrum is its surface layer of cortical cells. There are several varieties of these cells arranged in a definite manner within a dense felt work of nerve fibers and supporting *neuroglia cells* (which are nonnervous in character). The convoluted surface of the cerebrum is covered with this gray nerve-cell tissue which varies from $\frac{1}{10}$ to $\frac{1}{8}$ inch in thickness. It is

[1] Herrick, C. J., *Brains of Rats and Men,* p. 70, 1926, reprinted by permission of the Chicago University Press.

[2] Herrick, C. J., *op. cit.*, p. 70.

said to cover a total surface, if spread out, of approximately 316 square inches.[1]

Again we are reminded of the potency of some small things: We are told that this magic fabric, some 16 × 20 inches square and $\frac{1}{10}$ inch thick, contains, in the average adult, from nine to eleven thousand millions of cells. At that these cells are not closely packed together; the greater part of the space is loosely filled with fibers and neuroglia cells and blood vessels. *There is still room to grow.* It is said that if these approximately ten thousand million cells were packed closely together in the form of a cube it would measure a little less than an inch on each edge, and would weigh a little over 13 grams—about $\frac{1}{100}$ of the total weight of the brain. *It is with these very cells, however, that we are at this instant trying to grasp the significance of their own structure.*

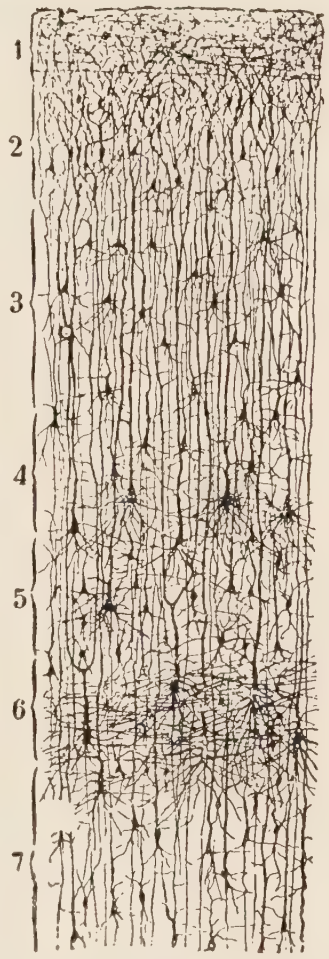


FIG. 108.—Section from the cortex of an infant, showing arrangement of cells and fibers—greatly enlarged. (*Ramón y Cajal, In the Proceedings of the Decennial Celebration of Clark University.*)

Let us look at Fig. 108, a classic picture by Ramón y Cajal, the famous Spanish neurologist. It is a drawing from a magnified fragment of this $\frac{1}{10}$ inch from the brain of a human infant. If it paralyzes the imagination to try to conceive of ten thousand million cells packed into a cubic inch, let us struggle with the effort of computing the possible contacts or associations of each of these cells with the others! In chap. I we saw the impressive list of figures resulting from the computation of possible combinations of the 20 amino acids. The conclusion was that enough kinds of proteins might thus be created to account for all hereditary traits in all the genes. Shall we not conclude, when we have somewhat recovered from our stupefaction, that the cerebral cortex is a mechanism adequate to account for all experience,

[1] CHILD, C. M., *Biological Foundations of Behavior*, pp. 122–123, Henry Holt & Company, 1924.

reasoning, memory, and thought? This is not saying that anyone is yet able to explain *how* this mechanism accomplishes these things, but it seems reasonable to assume that the processes of intellection do reside within these structures, and that enough contacts and combinations are possible between these cells to keep one thinking without repetition for the duration of an ordinary lifetime.

With the appearance of the cortex, associative memory and accommodative behavior become possible and gradually dominate and largely replace reflex and instinctive behavior. The insect which has nothing but reflex mechanism—no cerebrum or cortex—has a remarkable equipment of reflexes ready to use when he is born but his nerve currents flow in set channels. Very little in the way of accommodative behavior or learning is possible. With such a flexible equipment as the human cortex, new combinations, contacts, and channels are forever possible, the newer science tells us, while life lasts. In terms of gradients, new gradients, both temporary and permanent (habits) are possible as long as the protoplasmic structures of the nervous system function.

Specific Cortical Areas.—Every human cerebrum exhibits, in each hemisphere, four major lobes (frontal, temporal, parietal, and occipital). These are wrinkled into definite *convolutions.* The convolutions have further smaller wrinkles or indentations and it is the supposition that the greater the wrinkling the greater the intelligence since this increases the surface or extent of "gray matter." Certain "areas" on specific convolutions on specific lobes are fairly directly connected with specific parts and organs of the body through the spinal and cranial nerve paths. An animal in whom a certain spot in the occipital lobe has been injured will be made blind although the eyes may be perfect. Injury to a certain area of the frontal lobe on one side will cause paralysis of the arm of the opposite side. The center for speech control and that for the hand are next to each other on the side controlling the hand naturally used in writing. There is some evidence that injury may result from forcing a left-handed child to use his right hand. In older texts a pictured map will be found setting forth specific motor and sensory areas on the surfaces of the various convolutions, fissures, and sulci (grooves)

of the cortex. Later experimentation shows that cortical activity is not so rigidly circumscribed in spots or areas as was formerly thought. The sensory tracts are less definite than the motor; in all tracts and areas association may take place with the greatest range and freedom. With all impulses, incoming and outgoing, coordination with the entire cortex is necessary. Herrick thus sums up the present scientific belief:

Specific mental acts or faculties are not resident in particular cortical areas, but all conscious processes probably require the discharge of nervous energy throughout extensive regions of the cortex, and the character of the consciousness will depend in each case upon the dynamic pattern of this discharge and the sequence of function of its component systems. This pattern is inconceivably complex and only the grosser features are at present open to observation by experiment and pathological studies.

No cortical area can properly be described as the exclusive center of a particular function. Such "centers" are merely nodal points in an exceedingly complex system of neurones which must act as a whole in order to perform any function whatsoever. . . . The essence of cortical function is correlation, and a cortical center for the performance of a particular function is a physiological absurdity, save in the restricted sense described above, as a nodal point in a very complex system of conduction paths. Those reflexes whose simple functions can be localized in a single center have their mechanisms abundantly provided for in the brain stem [old brain]. The cerebral cortex of the resting brain is probably in a state of incessant activity, *i.e.*, it possesses a certain physiological "tone." This activity may be conceived as a system of equilibrated nervous discharges. This is not necessarily a conscious process, but it has a characteristic pattern in each individual which lies at the basis of his disposition or mental type. . . . If this activity involves the cerebral cortex of a human brain, it may be a conscious activity, the kind of consciousness depending on the kind of discharge. But the consciousness must not be thought of as localized in any cortical area. The discharge in question may reverberate to the extreme limits of the nervous system and the peripheral activities may be as essential in determining the conscious content as the cortical.[1]

K. S. Lashley says:

For man a great variety of habitual activities are known to be dependent upon particular areas of the cerebrum, but the localization is rather

[1] Herrick, C. J., *Introduction to Neurology*, pp. 334–335.

gross. Very small injuries rarely produce symptoms; larger injuries lower the efficiency of many complex related functions.[1]

We quote from the same author's *Brain Mechanisms and Intelligence:*

The learning process and the retention of habits are not dependent upon any finely localized structural changes within the cerebral cortex. The results [of his experiments with animal cortices] are incompatible with theories of learning by changes in synaptic structure, or with any theories which assume that particular neural integrations are dependent upon definite neural paths specialized for them. Integration cannot be expressed in terms of connections between specific neurones.

The contributions of the different parts of a specialized area or of the whole cortex, in the case of nonlocalized function, is qualitatively the same. There is not a summation of diverse functions, *but a nonspecialized dynamic function of the tissue as a whole.*[2]

The Brain of the Child.—It is not yet possible to correlate the development of the brain with the behavior of the child in the careful, explicit way in which Dr. Coghill has correlated the development of the nervous system with the developing behavior of Amblystoma. This must come before it will be possible fully to understand and most wisely assist the development of the child. The structure of the brain and the behavior of the human child are so infinitely complex that no one scientist or group of scientists can hope to do more than work out one or a few details. Many individuals and many groups are doing just this and are integrating their results within the Committee on Child Development of the National Research Council, the various White House Conferences, and more or less within all scientific staffs and organizations. As will presently be seen, findings are already modifying methods in child management and in education.

We have just looked at the general structure of the brain and nervous system and briefly considered its history. We wish now to review what is known as to the way the human brain develops during infancy and childhood, especially in what particulars, if any, the child's brain differs from the adult structure.

[1] *Foundations of Experimental Psychology*, chap. XIV, Nervous Mechanisms in Learning, by K. S. Lashley, Clark University Press, 1929.

[2] Lashley, K. S., *Brain Mechanisms and Intelligence*, p. 176, reprinted by permission of the University of Chicago Press, 1929.

The brain of a human embryo of five or six weeks shows close resemblance to that of fishes (Fig. 109).[1] At birth his cerebral cortex is still unfinished and the conducting nerve fibers are largely unmedullated. Lashley says that the transformation of neuroblasts (embryonic ectodermal cells) into neurones continues for a long time after birth and that the development of behavior depends upon this and upon the growth and prolifera-

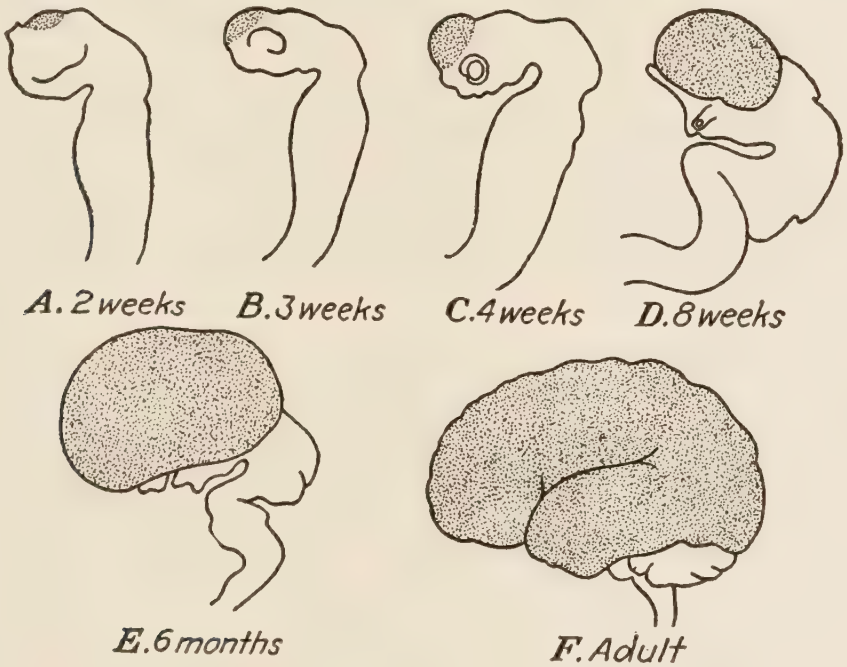


FIG. 109.—Development of the cortex in the human embryo. (*After Herrick, Neurological Foundations of Behavior, Henry Holt & Company.*)

tion and myelination of nerve fibers; also upon growth in cell size and resultant modification in cell chemistry.[2] It is said that at birth the child's brain cells are without Nissl bodies.

At the beginning medullation takes place principally in those fibers which extend downwards from the cortex, and upon whose functioning the voluntary motion of the limbs is dependent; thence it extends to such fibers as connect the cortical areas with one another.[3]

Ramón ý Cajal is quoted by Herrick thus:

The extension, the growth, and the multiplication of the appendages of the neurones, moreover, are not arrested at birth; they go on after

[1] HERRICK, *Neurological Foundations of Animal Behavior*, p. 166.

[2] *Foundations of Experimental Psychology*, chap. XIV, Nervous Mechanisms in Learning, Clark University Press, 1929.

[3] KOFFKA, *op. cit.*, p. 57.

that time; and there is nothing more striking than the difference between the nerve cells of the new-born and those of the adult as regards the length, number, and complexity of their ramifications. Doubtless exercise is not without influence upon these alterations, which are probably more marked in certain spheres of the brain of the cultured man. Lack of exercise, on the other hand, should evoke in the inactive spheres of the brain of both cultured and uncultured men those phenomena of resorption which have been observed during the embryonic period and which here come to expression as forgetting, etc.[1]

Herrick says the axis-cylinders (nerves or myelinated fibers) of the cerebral hemisphere mature—that is, acquire their myelin sheaths, without which they cannot function—at various stages in the development of the brain, some of these systems of fibers appearing before birth and some after birth. Flechsig formulated a law expressing the manner in which these nerves become ready for function which is called "Flechsig's fundamental myelogenic law."[2] "The myelination of the nerve fibers of the developing brain follows a definite sequence such that the fibers belonging to particular functional systems mature at the same time." He also states that in the cerebral cortex there are two great functional classes of fibers: the *projection fibers* which connect the cortex with the body, and the *association fibers* which intimately connect the cortical cells with each other. The projection fibers, he says, mature in advance of the association fibers. This would seem to explain the observed fact that children make the acquaintance of the world as experienced by their bodies for a good while before they reason much about their experience.

Dr. Papez calls the projection system the "extrovertive mechanism," and says it is the more primitive cerebral mechanism dealing with reactions to immediate situations, while the association fibers constitute the "introvertive mechanism" which is later and more complex.[3]

Dr. Coghill believes that nerve cells, like seeds, grow according to their "inherent potentiality" and according to "a definite pattern," but that the direction of growth and their orientation

[1] Herrick, *Brains of Rats and Men*, p. 53.
[2] Herrick, *Introduction to Neurology*, p. 322.
[3] Papez, *op. cit.*

with other structures depend upon such surrounding conditions as "metabolic gradients," "limiting membranes," "vascularization," etc. He tells us that the nerve cell is from the start more than a conducting mechanism, it is a dynamic system reacting to its environment after the manner of a living organism, with "conduction" its accessory or secondary function. He declares: "if it ever loses its potentiality of growth and differentiation we do not know when or where."[1]

It is well known that nerve cells when once destroyed are not regenerated or replaced (see page 448), but cortical cells with their axones and dendrites develop from neuroblasts (embryonic cells) and certainly grow in size and length as the child grows. Dr. Coghill shows that growth of the ends of dendrites and axones of microscopic dimensions has a tremendous effect upon behavior.

> By the growth of terminals of nerve cells over a distance of less than one four-hundredth of a millimeter, the animal (Amblystoma) is transformed from one that must lie helpless where chance places it into one that can explore its environment in response to impulses from within or stimulation from without . . . In a biological sense Amblystoma is certainly solving its immediate problem of survival by means of growth of neurones that are already functional conductors.[1]

Dr. Erik Agduhr of Amsterdam states that growth in nervous function is due not only to advancing myelination, but also to increase in number of neurones, axones, and root fibers. He says that these may come from undifferentiated tissue in reserve. This increase goes on more rapidly during the very early stages of postnatal growth but it continues for some time. He also believes that he has proved in the case of mice that this differentiation of new neurones may be affected "by suitably adapted and gradually increased training."[2]

Langworthy says that "fibers and tracts become medullated in the order in which they have developed phylogenetically"

[1] Coghill, *op. cit.*, pp. 84–85.

[2] Agduhr, Erik, The Postembryonic Growth of the Nervous System, *Journal of Nervous and Mental Diseases*, November, 1928 (quoted from *Child Development Abstracts*).

(during evolution). It is probable that tracts become medullated at the time when they become functional.[1]

How long the growth of dendritic terminals continues is not known, but doubtless for as long as the brain and skull continue to increase in size, and it seems probable, as has been said, that microscopic extensions may continue indefinitely and "that there is compensation for their increase by decrease of other tissues." We saw (page 447) that much of the brain space is

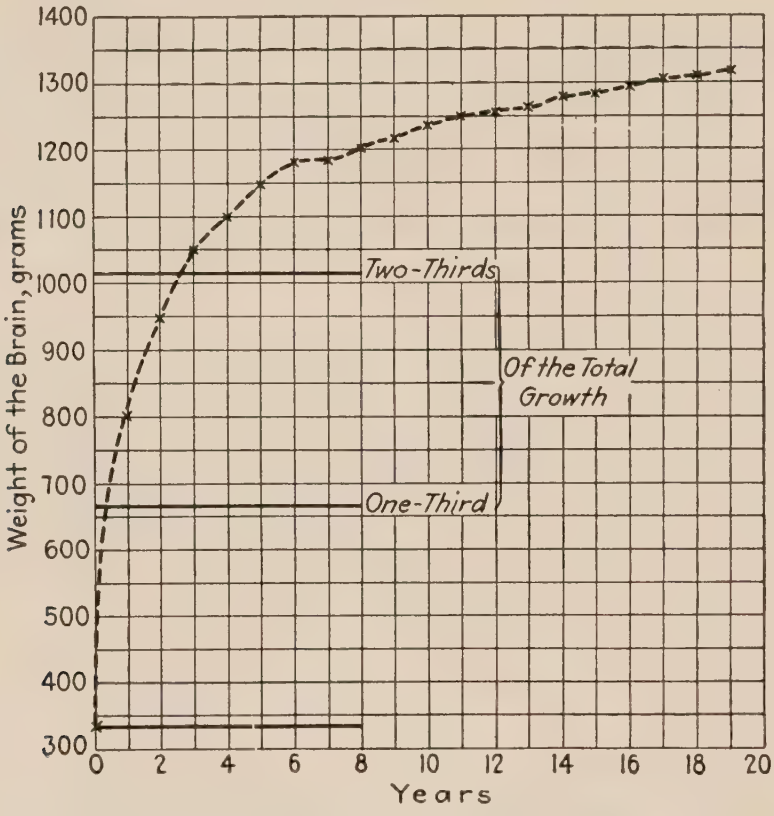


Fig. 110.—The postnatal increase in the weight of the brain. (*Karl Bühler, Mental Development of the Child, Harcourt, Brace & Company.*)

actually occupied by fluid and loose supporting tissue; it would seem to be constructed to allow for the suggested contingency.

Dr. Coghill makes a very definite distinction between the basic neural structures which are laid down *before function begins, in advance of excitation or experience,* and the more sensitive or flexible extensions of these which appear after function begins and *which may be modified by experience,* and which, he believes, are susceptible of indefinite growth and extension through microscopic but significant increments.

[1] Langworthy, O. R., The Myelination of Tracts in the Nervous System, *Journal of Comparative Neurology,* Aug. 15, 1928.

The application of these facts and theories to learning will be considered in subsequent chapters.

On page 398 we saw, by Dr. Scammon's graphs and by Bühler's graph (Fig. 110), that the brain mass follows a strikingly different rate of growth from that of the other parts and organs of the child's body. The brain develops far more rapidly than any other body structure, and it also becomes arrested, as far as measurable increase in size and weight is concerned, at about the age of ten. This fact is shown in (Fig. 88) where we see the relative proportions in size of head and body at different ages.

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CHAPTER XXVI

NEW THEORIES OF BEHAVIOR AND LEARNING

Think not because the chrysalis struggles that it is in need of you. Oh I pray you, stay your eager hand lest you despoil its silver wings.

MURIEL STRODE.[1]

The Mystery of Behavior.—We have spent some time in consideration of the elaborate equipment for behaving with which Nature has endowed Our Child. It would make our relations with him extremely simple and satisfying if it were possible, at this stage of human knowledge, to go on and state just how this mechanism produces thought, memory, consciousness, volition, and feeling. Since the simplest protoplasmic reaction is still a complete mystery, we can only confess utter ignorance as to how the magic fabric of the cerebral cortex operates to store experience; to reproduce this as conscious memory; to arrange past and present experience in creative thought, and to motivate these with emotion.

However, some of the phenomena associated with these mysterious performances are being observed and from these observations certain more or less serviceable conclusions are being drawn which may help us somewhat in our guidance of the child. Some of these phenomena and conclusions will now be reviewed, preliminary to a consideration of behavior in its practical aspect of training.

Development Levels (Maturation).—Perhaps the most significant idea which is modifying our interpretation of the behavior of the child is the maturation concept, which is based directly upon the discoveries cited in the previous chapters. When Dr. Coghill's Amblystoma had achieved lateral, segmental groups of neurones, not yet in communication with each other by means of the floor plate or commissural cells which connect the nervous mechanisms of the two sides of the body, it could move only the

[1] *My Little Book of Prayer*, Open Court Publishing Company.

side stimulated and could achieve a reflex coil to that side, which slowly returned to the straight position. The instant a microscopic increment of the ameboid-like process of the floor-plate cell closed the circuit between the duplicate lateral mechanisms, the animal became able to swim by contracting alternate sides in rapid sequence. A little later. as Dr. Coghill dramatically

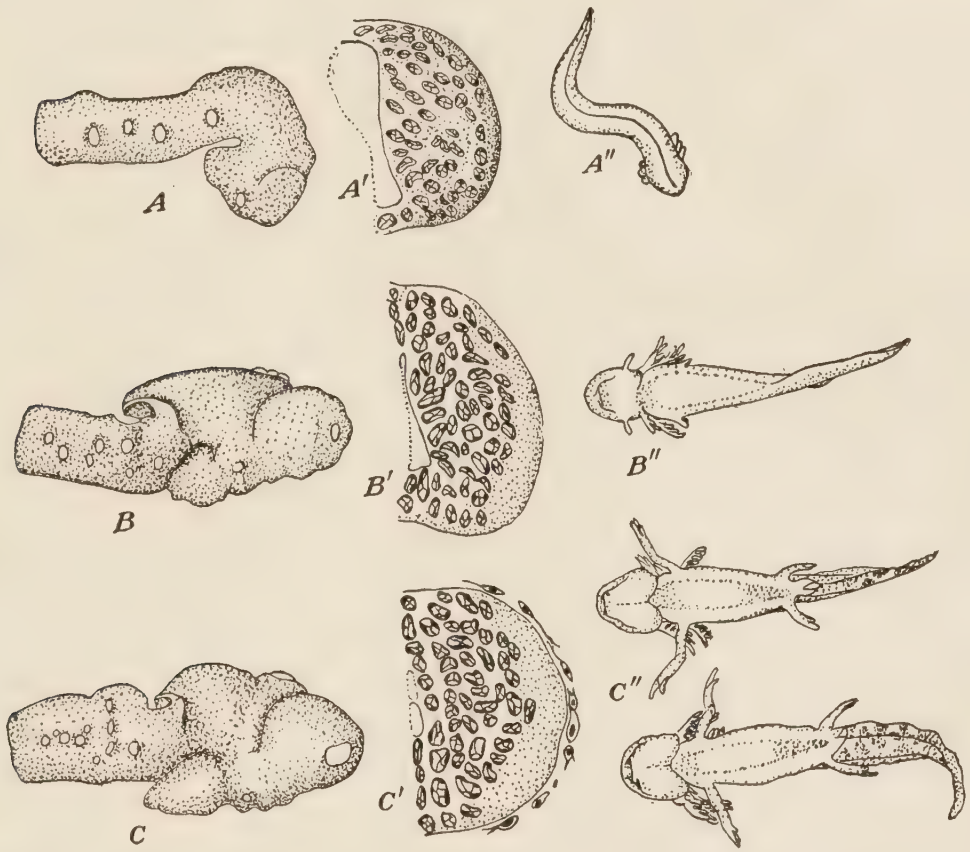


FIG. 111.—Stages in the development of the Amblystoma. Drawings of brain models, camera lucida drawings of transverse sections of spinal cord and of the Amblystoma itself. *A*, *A'*, and *A''* at the early swimming stage. *B*, *B'*, *B''* when the limb can move only as the trunk moves. *C*, *C'*, *C''* at the time when the animal begins to walk. (*After Coghill.*)

relates, another microscopic increment effected the connection of the nervous mechanism of the budding limbs (prepared in advance of function, we remember) with the cerebro-spinal system, and presto, the range of behavior of Amblystoma is enormously increased; he can move his limbs separately, he can propel himself upon the ground—he has become a land animal as well as a water animal!

In similar manner medullation of conducting fibers by groups makes it possible for the child to achieve new coordinations and new accomplishments. It is a relatively new idea that these

developmental processes may afford at least as reasonable a theory of the learning process as do the facultative, associational, conditioned reflex, trial-and-error, synaptic, and other theories of learning of ancient-to-recent memory.

At any rate, a great deal of attention is now being given to the study of the developmental progress of the child, as demonstrated by his functional capacity and behavior at his various chronological and physiological ages considered apart from training.

The concept of developmental maturity as definitely limiting and conditioning the behavior pattern, behavior response, and learning capacity, is rapidly modifying educational method. The educational world, notably the considerable group now interested in the education and training of the preschool child, is carrying on an ever expanding program of research and observation calculated to determine the spontaneous sequences of behavior reactions as these occur in the normal child, since it is believed that such behavior reactions define the maturation levels of the nervous system.

The linkage of these reactions with the actual anatomical and neurological development must, in the nature of things, come more slowly. The orderly observation of behavior from a developmental point of view is, however, clarifying the technique of child management to a markedly helpful extent. A review of the results of these observations, up to the present time, will be given in subsequent chapters.

The organismal or configurational concept is the second radical product of recent research in the psychology of learning. This concept, which has been discussed in its biological application in earlier chapters, is based primarily upon the assumption that the living organism functions in accordance with general physical laws as these laws are understood by science at the present time. As the Einstein theory of relativity has introduced *time* as the fourth dimension of physical phenomena and makes all phenomena *relate* to all other phenomena within the circuit or closure of its organization, and calls attention to the fact that nothing is static, or still, not even the atoms or molecules in the hardest known substance, *hence time constantly alters this "interrelation;"* so we must consider the behavior of a child, for instance, not as an isolated fact to be detached and analyzed as a chemist may

analyze a sample substance in a test tube, or as psychologists formerly analyzed mental faculties. We must now consider that the particular aspect of behavior under consideration is *related* to all the forces which have produced the child up to the moment of the particular reaction in question, and also inextricably related to all the conditions in force at that moment, and that all of these factors are changing in relation to each other as time passes even while we are recording the event.[1]

"Time permeates every corner of physics, says Eddington. . . . . The same kind of time surely permeates every corner of developmental phenomena."[2]

This brings us to the second organismic principle, namely, that *there is a universal cosmic tendency toward organization.* The elemental atoms form molecules, the molecules form crystals and compounds; star dust coheres to form worlds and solar systems. We have seen the elements of the earth struggle toward patterned complexity in life forms. Isolation or fragmentation is nontypical and chaotic anywhere—in solar space, in living forms, or in thinking. The configuration psychologists tell us that closure, patterned grouping, organization, is a fundamental compulsion in thinking, no less than in physical growth, heredity, crystal formation, or the grouping of a solar system.

When we try to put these two ideas together—relativity and pattern—they integrate very consistently. Life ever struggles toward patterned form and expression, a struggle into which the factors of relativity to environment and time ever enter. Why should not the mental life, which we are now compelled to accept

[1] "This new psychology goes by the significant name of the Gestalt psychology, which means in our language the configuration psychology, and is perhaps chiefly remarkable for its intimate connection with modern physics. . . . For just as Einstein gave an impetus to physics by expounding the relative nature of space and time, so the champions of configuration psychology have been assiduously engaged in the attempt to demonstrate the relative character of our mental life, and have thereby imbued present-day psychology at large with renewed vigor" (Paul Chatham Squires, A New Psychology after the Manner of Einstein, *The Scientific Monthly*, February, 1930).

[2] *The Foundations of Experimental Psychology*, chap. XVI, The Individual in Infancy, p. 629, by Arnold Gesell, Clark University Press, 1929.

as a function of organized living protoplasm, tend to operate in relative and patterned form? After all, is not all thinking, all conscious life (as well as, manifestly, all unconscious life) an expression of struggle for organization, closure of form, a rebellion against fragmentation and incompleteness of experience? The "configuration," "the Gestalt," the "whole," the "pattern," *is the reality*, and it is something different from the sum of its parts in thought as well as in physics and biology.

According to this theory of learning and reality, learning takes place, not by practice, trial-and-error, or any other scheme for constructing wholes from parts, but rather by closure of factors to form a mental configuration. When the physical mechanism is ready ("matured"), and when a *whole* is formed, mental *insight* results and the fact is *learned.* Until maturation and organization are complete no amount of repetition or trial is fruitful. Insight occurs sometimes during repetition, because the conditions happen to be realized which produce a configuration or pattern. Insight may occur with the first trial, after any number of trials, or never, according to whether or not a configuration results.

Drill is entirely useless except as an expensive way of seeking "configuration";[1] educational effort must be directed toward helping the child to acquire organic concepts of wholes. This somewhat resembles the old idea of "helping him to understand." The child eventually learns the alphabet because the letters suddenly click together as an idea, a whole, something out of which language is made. Up to that moment he struggles with it in vain. The difficulty inherent in this particular effort of ancient memory has long since led primary educators to present *sentences* and *paragraphs* to the child as configurations or wholes, then, when these have become realities or meaningful wholes to him, they are broken into parts,—words and letters, smaller configurations—which then have meaning. This was done empirically before any one had heard of "Gestalt."

Habits and conditioned reflexes are configurations (gradients) which become more or less firmly set, although the configura-

[1] Drill or repetition is useful *after a configuration is established* for the purpose of converting temporary into permanent gradients or habits, and for acquiring skills in performance via cerebellar coordinations (see page 443).

tionists can come no nearer than their predecessors to explaining the precise factors which determine either permanence or fluidity of reaction. It is quite probable that the synapses play a rôle, but this is speculative.

The "repressions" of the Freudians may be considered as incomplete or fragmentary experiences of such vivid character that they have persisted, unfinished or unsatisfactorily or inharmoniously finished, in the subconscious mechanism of mental life, possibly to be brought to the surface and "completed" by some psycho-analyst who builded better than he knew in bringing repose to a personality which had been struggling futilely toward an uncompleted goal.

The effort for closure or completion of experience the configurationists call *struggle toward a goal.* They also say that in all Nature energy flows toward a goal, but in the direction of greatest ease, least resistance; or as they prefer to say, all effort follows the path of "least action."

When it comes to applying these simple rules to particular complexly organized situations, like habit formation, the theory of the gene, atomic structure, or any other of the lawful procedures of Nature, the wholes become intricate and the subject involved. We need not let these intricacies trouble us greatly, however, in our effort to interpret the unfolding behavior of the child. We shall simply continue to keep our grasp upon the organismic thread and observe the general trend of natural law without wandering too far in bypaths as yet uncharted and unknown.

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CHAPTER XXVII

BEHAVIOR LEVELS

Development is always dynamic and never discontinuous. It is, therefore, impossible to separate one period of development sharply and completely from any other period of development. The fetal period is continuous with the neonatal, the neonatal with the preschool, and this in turn with the school period, pubescence, adolescence, and adulthood. Indeed, the biologist goes still further. He does not even separate senescence from immaturity. Some of the most penetrating studies of growth and development have emphasized the fact that senescence and rejuvenescence are relative terms and that both processes may go on at the same time in one individual. As Child puts it, 'The age changes in the organism are merely one aspect of Werden and Vergehen, the coming and passing away which make up the history of the universe.'

ARNOLD GESELL.[1]

Developmental Periods.—In this chapter an attempt will be made to follow our thread of continuity through the reported findings of various studies of child development and behavior. It will simplify presentation if some age classification is adopted, and the one used by Gesell is perhaps as satisfactory as any. Dr. Gesell classifies the entire growth period roughly into four sexennial periods by the eruption of the molar teeth. The first six-year period terminates with the eruption of the six-year molars, the second at about twelve with the eruption of the second quartet of molars, while the wisdom teeth, the third quartet of molars, usually begin to erupt by eighteen and are fully erupted by twenty-four.

The first period, the one which is the subject of our study, he subdivides into: the *neonatal*, the first four weeks of life; *infancy*, or the *perception-prehension* period of about ten months; *later infancy*, or the *language-locomotion* period, lasting up to about two years. The remaining preschool period may be termed, rather vaguely, *early childhood* or the *socialization* period. Gesell says:

[1] *Mental Growth of the Preschool Child*, The Macmillan Company, 1925.

These periods merge and are profoundly continuous in the organic unity of the life-cycle. The neonatal period is really but an extension of the prenatal period, and in cases of premature birth actually coincides in a measure with the latter.

One may think of infancy as an epoch in an individual life-cycle; but from the broad standpoint of psychobiology infancy constitutes an intricate trait-complex—a complex which has changed through the ages and is still in process of change. As such it is one of the most complicated end-products of evolution. Infancy itself was evolved to subserve the needs of growth. It is not simply an interval in which an individual manifests growth, it is a *method of growth* by which the potentialities of the life-cycle are ultimately realized.

Infancy is therefore not purely a prologue or a metamorphosis. From the organismic viewpoint infancy plays a positive persisting rôle in the attainment of the total life-career.[1]

Dr. Gesell calls attention in various writings to the fact that growth tends to follow an ordered pattern and will do this in spite of retarding or discouraging circumstances such as illness, malnutrition, bad hygiene, or what not. It has long been observed that children may "outgrow" the effects of untoward conditions to a very surprising extent, making such rapid gains, for example after an illness or a tonsillectomy, that the child "catches up with himself" and after a time may exhibit little or no trace of the experience. He believes that the general outlines of development in the human child may be rather definitely indicated in terms of chronological age periods. In the article quoted above he says:

> The events of growth and of behavior are ordered; they fall into temporal sequences. There may be telescoping, elision, hastening, slowing; but the events will always appear, so to speak, in a time frame, and have a durational design which can be expressed in temporal terms. Theoretically, every genetic phenomenon can be dated. . . . Inasmuch as genetic phenomena are time-linked, and are fundamentally conditioned by duration, accurate age data are fundamental for the expression of the patterns of growth, whether seen in cross section, longitudinally or biographically. Age norms or age values are necessary for the formulation of the trends of typical and deviational characteristics.[2]

[1] *The Foundations of Experimental Psychology*, chap. XVI, The Individual in Infancy, by Arnold Gesell, p. 629, Clark University Press, 1929.

[2] *Ibid.*

Gesell also calls attention to the need for a more fixed point of departure in the calculation of behavior norms than physiological birth, since this may be qualified by prematurity or by delayed birth. The logical zero point would be the date of conception, were it possible to establish this (see page 130). Since this is not possible, the birth date must be used with such adjustments as the evidence in each case makes possible.

Prenatal Behavior.—Studies of fetal movements in experimental animals, notably the white rat and the guinea pig, show that the spontaneous activities of the embryo and fetus follow fixed and ordered sequences. The first movements occur in the head region and progress tailward in the manner which the development of the cerebro-spinal nervous system (described in previous chapters) would lead us to expect. The behavior development of the embryo rat is so rapid that intervals of one hour are significant and the time units of observation must be very brief. The appearance of new behavior reactions are being found to correlate with the maturation of new nerve cells, the myelination of nerve fibers and the branching and extension of nerve endings as described in the previous chapters.

Some fragmentary observations have been made upon the human fetus in instances of Caesarean delivery in which premature infants were born alive and survived for brief periods of time. Strassmann observed slow movements of arms and legs of a seven weeks' embryo. Minkowski observed mouth and chin movements on lip and tongue stimulation in a three months' fetus. From the fourth to the fifth month patterned reflexes appear, such as moving the left hand when the right foot is stimulated (called the "trot reflex"). Various postural, rhythmic, and inhibitive reflexes were observed—all following an orderly genetic sequence in their emergence. "Genetic sequence is itself an expression of elaborate pattern."[1] By seven months the behavior equipment is sufficiently mature that the child, if born at this time, will cry, suck, breathe, digest, and eliminate and frequently survives.

Birth is only an incident in the developmental career of the infant. If born too soon he completes his postnatal development

[1] Gesell, Arnold, *The Guidance of Mental Growth in Infant and Child*, chap. XVIII, p. 276, The Macmillan Company, 1930.

in much the same manner in which it would have occurred in utero. If postmature or delayed birth occurs the child goes on maturing in utero and when born behaves like a child of two weeks (or whatever the interval). Gesell finds that children born prematurely are retarded in their behavior reactions and remain retarded for as long a period as the tests have been applied.[1]

Behavior at Birth.—The human infant is born with a certain amount of behavior equipment, prepared and made ready in advance of function. He is the most meagerly equipped with ready-to-use action mechanisms of all living young things. The most elaborate behavior machine in the known universe, he lies in almost perfect helplessness, awaiting the further completion of his structure through cell development, and myelination and the extension of nerve fibers.

It must be borne in mind that the behavior mechanisms which are prepared in advance of function are phylogenetic, stable, and relatively unchangeable; while the structures and parts developed during use or experience are in a measure ontogenetic and are definitely influenced or modified in both developmental and function by experience (see page 37).

Of the older, phylogenetic structures, the autonomic nervous system, which adjusts the operations of the vital organs and regulates purely physical behavior, is the most stable, the most incapable of learning or adaptation. Next to this come the simple reflexes. The knee jerk and pupillary reflex, for example, probably never can be conditioned or modified.

When the child is born his autonomic mechanism is pretty completely functioning, as is shown by the facts that his circulatory system is adjusting itself through vasomotor constriction and dilation, and that his digestive system with its secretory glandular mechanism becomes pretty completely operative within a few days (see page 277 on feeding during the first few days of life). He can suck, swallow, digest, urinate, and defecate. His sense of taste is fairly acute, accepting sweet and salt and refusing sour and bitter. The eliminative mechanisms, kidneys, bowels, skin, are thrown into gear, and the entire, subcortical,

[1] Gesell, Arnold, *Infancy and Human Growth*, chap. XV, The Mental Growth of the Premature Infant, The Macmillan Company, 1929.

kinetic mechanism is removed from the placental shop where it has been under construction, placed upon its own base, and with the release of the respiratory button, so to speak, it enters upon its trial run as an independent organic mechanism.

In addition to these vital phenomena the child at birth is equipped with a mechanism for differentiating between comfort and discomfort. As indicated in the previous chapter, this mechanism is probably closely identified with the autonomic and subcortical structures of the brain and nervous system.

The first behavior reaction of the newborn child is the so called "birth cry." This marks the turning of the switch which diverts the circulation into new channels, wakes up the brain by flooding it with oxygen (is this the beginning of consciousness? Who knows?), and releases the vocal mechanism which has so mysteriously been made ready for function.

The stimulus to the birth cry is possibly, in part, the release from the rather terrific intrauterine pressure of the last stages of birth. This sudden release of pressure in itself causes the mouth automatically to open, thus admitting air into the collapsed air passages. The cessation of the placental circulation causes accumulation of CO_2 in the blood, which may act as a stimulus to reflex action. The inflation of the lungs, together with the impact of the relatively cold air upon the body surface, effects drastic and sudden adjustments in the circulation. How all this affects the sensory centers, or cortical consciousness is, as yet, purely a matter of speculation. It is safe to assume that at best conscious sensation at this period must be a vague generalized affair, the "matrix," or "ground," out of which formless void the configurationists conceive definite impressions to appear as maturation and experience proceed. However, such capacity for conscious experience as the new-born infant may have must be filled with unpleasant if not painful impressions.[1]

Random movements of the head, arms, and legs occur in much the pattern of the intrauterine movements. Early observers thought these resembled swimming movements and attached recapitulatory significance to them. This seems to have been disproved. Watson reports that infants placed unsupported

[1] *The Unconscious, A Symposium*, Prenatal and Early Postnatal Behavior, by Marion E. Kenworthy, p. 187, Alfred A. Knopf, 1929.

in water only struggle in a random manner and exhibit terror. The pupillary and patellar (knee-jerk) reflexes are present. In most new-born, if the bottom of the foot is stroked usually the toes spread and the great toe jerks upward (the Babinski reflex). This is considered significant, since the normal reflex, when the spinal reflex arc for this region is complete and intact, is for the toes to curl under. Within the first year the Babinski reflex normally disappears, showing that maturation of the centers has occurred, and it is never to be seen afterward except in the case of certain nervous disorders affecting the part of the spinal nerve cord in which this reflex center is found.[1] Recent observations under strictly controlled conditions show considerable irregularity in occurrence of the Babinski reflex, and it appears that it may be incidental or accidental, at least in some instances.[2]

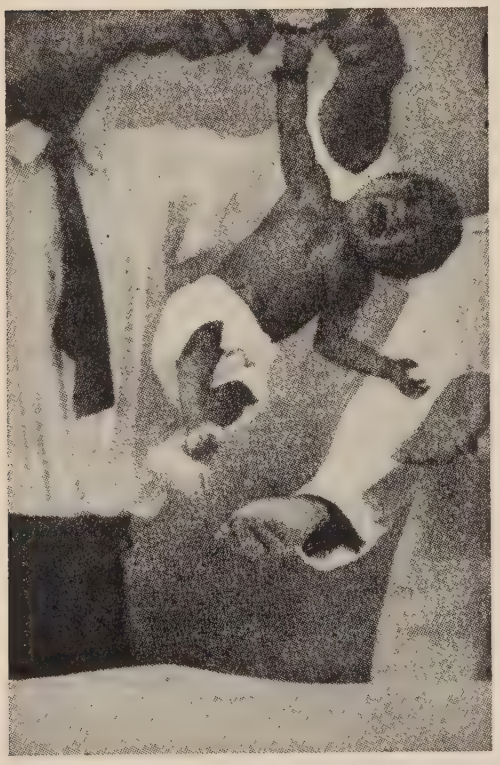


FIG. 112.—Newborn infant suspending his weight by his hand. (*Courtesy of Dr. Curt P. Richter.*)

If a rod is held under the toes, the toes curl round it but without much grasping force. If a rod or adult forefinger is held within the palm of the hand, the fingers grasp this strongly, and the normal infant will suspend his entire weight from this for several seconds and even minutes (see Fig. 112).

The infant, if laid upon its face, will turn its head to one side to enable it to breathe, and some infants will even raise the head momentarily from the table. Mrs. Blanton observed certain infants who could turn over from face to back "almost from birth."[3]

[1] WAGONER, LOVISA C., *The Development of Learning in Children*, pp. 54–55, McGraw-Hill Book Company, Inc., 1933.

[2] JOHNSON, BUFORD J., *Child Psychology*, chap. III, Infant Responses, Chas. C. Thomas Publishing Company, 1932.

[3] WATSON, J. B., *Behaviorism*, p. 95, People's Institute Publishing Company, 1925; also MARGARET GREY BLANTON, The Behavior of the Human

If the nose is held, defensive, slashing movements of the arms occur during which they may be directed with some force against the offending hand. If one leg is held immovable by a hand against the knee, the other leg will kick violently, also *apparently* a defensive effort to remove the restraint.

Blanton and Watson in Johns Hopkins Hospital observed that the infant who is hanging his weight by his hands makes "climbing" movements characterized by rhythmic waves of contraction of the trunk and hip muscles.

Miss Shinn reports that her niece evidently felt the difference between light and dark on the first day, turning toward the light. She thinks this is a pure reflex (phototropism) just as a plant turns toward light. There was no evidence of seeing, she says, during the first fortnight. The eyes did not wink at passes made toward them, and the eye movements were not well coordinated. She says her niece gave no evidence of hearing until the third day, when she was startled at the tearing of paper and other harsh noises.[1]

Watson and others believe they have proved that the child at birth shows fear of loud noises and of falling. Recent observers believe the reaction of acute discomfort interpreted as fear in these situations is really due to the violence of the stimulus rather than to its specific character, *i.e.*, the impact of the sound and the jolt of the drop actually cause physical pain, or at least acute internal organic disturbance.[2]

Infant during the First Thirty Days of Life, *Psychological Review*, vol. 24, 1917.

[1] SHINN, MILLICENT, *The Biography of a Baby*, by permission of, and arrangement with, Houghton Mifflin Company, 1900.

[2] Pratt, Nelson, and Sun report that, in the investigation of the response to external stimuli of healthy infants during the first two weeks of life, they found no evidence of fear, rage, and love, nor even of the defense reactions reported by other investigators in this field (PRATT, NELSON, and SUN, *Behavior of the New-born Infant*, Ohio University Press, 1931).

Sherman says: "Any form of *sudden* stimulation, such as dropping, loud noises, restraint, pain, or a rush of air on the face, produces in the young infant aimless activity of most of the musculature, accompanied by crying. The stimulus must be sufficiently strong, however, to produce a reaction. When an infant below four or five days of age is dropped one or two feet it frequently shows no perceptible response, except for occasional vague movements of the arms and legs. The younger the infant the stronger must

The tactile response of the new-born is fairly acute. A light stroke upon the cheek and foot will provoke sucking and the Babinski reflex respectively. The pain response, however, is not well developed at birth. Sherman reports that the infant gives no response to the single prick of a needle until some 18 hours following birth. Incidentally, the face is much more sensitive than the feet. Minor operations, such as circumcision, can be performed during the first few days without anaesthesia.

Sherman attributes the order of development of the reflexes in the fetus to their defensive and survival value.

> Sucking and swallowing are necessary for feeding and survival. Sneezing . . . one of the first reflex reactions, is purely a defensive activity, since it brings about a rapid expulsion of air from the nostrils and thus tends to remove a noxious stimulus. The mucous membranes are most sensitive to contact and to mild irritation, and they are also most easily injured by noxious stimuli. In general, there seems to be a direct relationship between the reactivity of a structure and its liability to injury.[1]

Although Dr. Sherman does not subscribe to the Gestalt theory of development and behavior, his description of the appearance of behavior reactions tallies strikingly with the observations of Child, Coghill, and others as mentioned previously in this text.

> The average number of stimuli necessary to produce a response is at all ages smaller for the face than for the legs. Sometimes infants less than six hours of age do not respond at all to as many as ten needle pricks on the legs. After five days every normal infant responds to a single needle prick on the face, but until about the seventh day there is no response to a similar painful stimulus applied to the legs.
>
> There are at least two factors determining the comparatively greater sensitivity of the anterior end of the body. First, the nerves for touch and pain have fewer synapses in the face and head region than in the extremities. The threshold at the synapse is higher in the new-born infant than in the adult, as many impulses have not yet passed over

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be the stimulus. This is true also for the so-called 'pleasurable stimuli' such as stroking or petting, to which many new-born infants show no overt reaction" (Sherman, Mandel and Irene Case, *The Process of Human Behavior*, p. 145, W. W. Norton & Company, Inc., 1929).

[1] Sherman, Mandel and Irene Case, *op. cit.*, pp. 64–65.

the nerve tracts, and impulses which must pass over a great many synapses have less chance to complete the final path.[1] Secondly, the distance which an impulse has to traverse is greater for the posterior end of the body than for the face and head.

A biological explanation may also be given. Physiologists have shown that in many organisms *metabolic activity,* or the process of chemical change in living cells, is greater in the anterior than in the posterior end of the body. Increased irritability and rate of conduction of impulses accompany this increased metabolic rate. We have seen how, in the evolution from simpler to more complex animal forms, the anterior end began very early to assume dominance over the rest of the body.[2]

Summary.—We thus see that the infant at birth has reached only a relatively rudimentary degree of development. Under the admirable adjustments of Nature he is ejected from his mother's body and detached from placental nutrition at the exact moment his own nutritive machinery is ready to take on independent function. His vegetative or visceral machinery is already functioning under the direction of his autonomic nervous system. His cerebro-spinal system is able to perform a few reflexes in which the motor activity exceeds the sensory. His cerebral cortex functions little if at all. He is unable to coordinate his activities. He is only vaguely aware of either the external world or his internal organism. His chief defensive mechanism is the cry (and what one device could secure more immediate attention to his needs?). He has very limited power of withdrawal from danger. He is probably entirely lacking in specific emotional differentiation or response, being aware probably only of comfort and discomfort. He seems to show generalized fear (with withdrawal or resistance, depending upon duration of stimulus) to all profound disturbance of his well-being.

From these beginnings we shall follow his further development.

[1] Sherman also (p. 75) says: "The synaptic junctions of new-born infants are imperfectly developed mechanisms over which many impulses must travel before certain *patterns* [italics ours] are established. . . . What particular pathways are established will depend upon the general structural relationships between the afferent and efferent nerve tracts and upon the functional relationships arising as a result of individual experience."

[2] *Ibid.*, pp. 69–71.

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CHAPTER XXVIII

THE NEONATAL PERIOD

Baby Fingers

Baby fingers are soft as rose petals are soft,
And pink as a pale peach blossom.
They are so delicately curled into the tiny palm,
Making a dimpled fist,
That it hurts,
And yet—they can tear the heart out from you.

Baby Hair

Baby hair is soft as a mother's sigh is soft,
And curls in wee golden duck tails
About a velvet neck.
The shine of baby hair has made a dark room light,
And a baby head pressed into the hollow
Of a homely woman's neck
Has glorified her.

Baby Eyes

Baby eyes are blue as cornflowers are blue,
And deep as a sleepy lake.
They seem to say in shy blue whispers,
"Listen, Listen"—
And you go on listening,
Looking deep down into them—
Until it is so deep you are lost.

Baby Body

A baby, lying under its coverlet,
Has curving lines and little warm rounded hills,
Like a pink Cherub's figure.
The curve of a baby arm
And the bend of a baby heel
Showing in a dim outline through the warm blanket—
Are like a poem,
Too beautiful to finish.

Can you tell me anything
That is more beautiful than a baby?

ELIZABETH BLEVINS.[1]

[1] *Anthology of Student Verse for* 1930, Los Angeles High School.

Experience as Training.—We have seen that life is ever a process of adjustment of the organism between internal and external conditions. Our child has been reacting to environment from the instant of his conception. The conditions of his prenatal life, however, were so ordered by Nature as to be preeminently favorable to the development of his innate pattern with minimum interference or necessity of adjustment to the very stable situation in his mother's womb. The fact that occasionally an infant is born with bodily defects or even with active disease processes acquired from the mother or, more frequently, predisposition to such diseases as rickets or tuberculosis, as well as the relatively high stillbirth rate, show that the child does react to his prenatal environment.

With the birth of the child, however, external conditions become abruptly and enormously complicated. Both development and behavior begin to be affected in a highly variable manner by experience. In our present state of knowledge the effect of experience is still, to a considerable extent, unknown and unpredictable; therefore, conditions are not always made favorable for the postnatal development of the infant.

The infant becomes, all at once, dependent upon the knowledge or caprice of adult human beings for the management and control of his experience. The deliberate management and control of the child's experience constitute his so-called *training*. Training (that is, the planned adjustment of conditions), to be effective and to contribute to the fullest development physically and mentally, must be based upon and follow the lines of his growth and maturation as indicated by the development of his nervous system. Training which attempts to elicit behavior responses contrary to or in advance of development results only in distortion of growth and personality, and establishes both conscious and subconscious conflict with the child.

The development and the behavior of the child are affected by his experience whether or not that experience is controlled in any orderly or deliberate fashion by his elders. His protoplasmic organism does and must constantly react to whatever may be its experience (environment) *according to its innate pattern.* After he is born this innate pattern possesses great adaptability and will be influenced in definite and more or less

permanent manner by any experience which occurs with sufficient force and regularity to permit protoplasmic or organic changes to take place. Even accidental and irregular experiences may interfere with patterned growth in a more or less harmful way.

The new-born infant seems to have a relatively undifferentiated state of development, in which patterns of organization arise as evidenced by his behavior. This is illustrated by the findings of Furfey and his coworkers, who devised tests and administered them to 62 infants in the maternity ward of Providence Hospital, Washington, D. C., for the purpose of discovering if any such factor as "general intelligence" or mental integration exists in the new-born child. Their conclusions are that

> no general factor is discoverable in the mental life of the new-born infant. *There are only specific groups of abilities involving specific parts of the nervous system. The infant at birth is not a mental unit. It seems reasonable to suppose that it is the maturation of the nerve tracts which welds these discrete elements into the integrated mental whole discoverable at the age of one month.*[1]

This study of functional behavior incidentally correlates with the neurological evidence quoted in chap. XXV to the effect that maturation occurs by groups or units of the nervous system rather than by diffuse, general growth.

Pratt, Nelson, and Sun, who worked for several years on an elaborately controlled study of new-born children, state in their conclusions:[2]

> The infant at birth represents an organism in which differentiation has proceeded to the point where there are many effectors and many receptors. Its behavior, however, is generalized, that is, stimulation of almost any group of receptors by almost any kind of stimulus will lead to a response in almost any part of the organism. The reaction tends, however, to manifest itself most strongly in that part of the organism which is stimulated, and from there spreads out with decreasing frequency and intensity to the other segments of the body. This does not mean that the activity within any given segment is well coordinated. . . . The new-born infant is equipped with quite a number

[1] Furfey, Benham, and Sargent, Mental Organization of the New-born, *Child Development*, p. 50, March, 1930.

[2] Pratt, Nelson, and Sun, *The Behavior of the New-born Infant*, p. 208, Ohio University Press, 1930.

of reflexes, but the degree of specificity and their significance seem to have been unduly exaggerated. For the most part these reflexes are vegetative [autonomic] in character, and even the others are in no way peculiar to human beings.

Even within the first two weeks one may observe a restriction of the generalized reactions as indicated by . . . an increasing specificity in the reactions to stimuli.

Irwin designates this generalized behavior "mass activity," and notes the fact that the various stimuli all tend to produce general bodily movement.

In seeking for an explanation of mass activity in new-born babies, it is here suggested that it probably lies in the immaturity of the nervous system. Our own view is a conservative one, set forth in the statement that the human infant during the first ten days is dominantly, although not entirely, a thalamic [autonomic] organism.[1]

Dr. Mandel Sherman reports that numbers of observers such as students of psychology, nurses, and medical students were hopelessly at variance in interpreting the cries and also the motor behavior of infants in a hospital. The infants were subjected to needle-pricking, dropping two or three feet, restraint of movement, and to hunger. The experiments were performed behind a screen which was quickly withdrawn. From 9 to 15 different causes for the reactions to these four stimuli were named by the various observers with no unanimity even among the nurses who were familiar with the infants. Dr. Sherman concluded that "most persons judge the emotional behavior of the individual in terms of the stimuli which have produced the reactions . . . rather than upon differences in overt behavior."[2] It is highly probable and consistent with the theory of maturation as the basis of behavior that differential crying begins to emerge from the early undifferentiated matrix of behavior by the end of the neonatal month.

[1] Irwin, Orvis C., The Amount and Nature of Activities of New-born Infants under Constant External Stimulating Conditions during the First Ten Days of Life, *Genetic Psychology Monographs*, p. 78, July, 1930.

[2] Sherman, Mandel and Irene Case, *The Process of Human Behavior*, chap. V, p. 142, W. W. Norton & Company, Inc., 1929.

With these considerations in mind we shall proceed to discuss the developmental periods which have been somewhat arbitrarily defined for the sake of convenience of presentation.

The Neonatal Period.—That the adjustments following birth are drastic is shown by the high rate of neonatal mortality. Of all infants born alive who die before reaching their first birthday, general statistics show that 50 to 70 per cent die during the neonatal month and fully half of these die during the first week.[1] Special statistics of groups of mothers and infants who have received standard prenatal and neonatal care during and following pregnancy show that with such care maternal and neonatal mortality is greatly reduced and according to some reports almost eliminated. This would indicate that enough is now known concerning the proper adjustment of natal and neonatal conditions to be effective as far as survival is concerned if generally applied.[2]

Neonatal Development.—We have considered the relatively meager equipment of the new-born infant and have found that the reason for his great helplessness is chiefly the unfinished state of his nervous system. During the neonatal month he develops both physically and mentally at a more rapid rate than during any other month of his postnatal life.

Dr. Gesell, who classifies development under the heads: motor control, language, adaptive behavior, and personal-social behavior, describes the developmental norms for the age of one month as follows.[3]

Motor development: (*a*) lifts head from time to time when held to the shoulder; (*b*) makes crawling movements when laid prone

[1] Macphail, E. S., Infant Mortality as Shown by Canadian Vital Statistics, *American Journal of Public Health*, vol. 17, p. 5, 1927; A Report on International Inquiry as to Infant Mortality by the League of Nations, *U. S. Public Health Report*, Sept. 20, 1929.

[2] Report of the Infant Welfare Society of Chicago, *The Nation's Health*, February, 1924; Oxford Mothers and Babies; a Community Plan and Its Results, *Mother and Child*, December, 1923; Effectiveness of Infant-welfare Clinics from a Medical Point of View, *Journal of the American Medical Association*, Mar. 11, 1922; How Villiers Le Duc Saves Her Babies, *Mother and Child*, September, 1922; Prenatal Care in Relation to Mortality, *Yearbook of the American Public Health Association*, 1931–1932.

[3] Gesell, Arnold, *Infancy and Human Growth*, p. 128, The Macmillan Company, 1928.

on a flat surface; (*c*) lifts head intermittently, though unsteadily, when in this prone position; (*d*) turns head laterally when in the prone position.

Language: (*a*) gives definite heed to sound; (*b*) has differential cries for discomfort, pain, and hunger.

Adaptive behavior: (*a*) stares at window or at massive objects; (*b*) gives visual heed to conspicuous moving objects; (*c*) gives transient visual regard to a red ring; (*d*) retains definite hold of the ring when it is placed in the hand.

Personal-social behavior: (*a*) makes tactually perceptible postural adjustments when taken up; (*b*) shows selective regard for the face.

Miss Shirley, in her study of the motor development of 25 babies from birth to two years, reports that "all of the babies went through almost the same series of reactions in approximately the same order." Their earliest reactions when they were in a prone position was turning the head to free the nose for breathing. During the first month most of them became able to lift the head so that the chin was free.

Miss Shirley records that new-born infants assume the fetal posture with knees hunched up, arms flexed and hands close to chin, but that most infants have outgrown this stage by three or four weeks.[1]

Miss Shinn in her classic record of the development of her young niece says, regarding the early behavior of her subject:

> Sensations had from the first the quality of being agreeable or disagreeable. The baby could not wish, prefer, and choose, for she had not learned to remember and compare; but she could like and dislike. And this was shown plainly from the first hour by expressions of face . . . A look of content or discontent, the monotonous cry, and vague movements of limbs, head, and features—these are the limits of expression of feeling in the earliest days. . . .
>
> Out of the new-born baby's dim life of passivity the first path was that of vision. I noticed about the end of the second week that her eyes no longer wandered altogether helplessly, but rested with a long and contented gaze on bright surfaces they chanced to encounter. . . .

[1] Shirley, Mary M., *The First Two Years*, vol. 1, *Postural and Locomotor Development*, p. 46, University of Minnesota Press, 1931; Fenton, Jessie Chase, *A Practical Psychology of Babyhood*, Houghton Mifflin Company, 1925.

It was not active looking, with any power to direct the eyes, but mere staring; when the gaze fell by chance on the pleasant light, it clung there. But something must have come to pass, that it *could* stop and cling to what gave it pleasure.[1]

Miss Shinn regards this passive staring as the beginning of power to control muscular movements, and says that from the beginning of staring irregular movements of head and eyes began to decline. During the fourth week Miss Shinn records what has the appearance of a conditioned reflex or, in later terms, a "Gestalt" or organic association. She says her niece, when crying with hunger, would hush as soon as she was taken in the arms in the position usual in nursing.

Miss Bryan of the psychological laboratory of Johns Hopkins University observed in the maternity ward of the University of Maryland Hospital a number of children for 10 days following their birth. Miss Bryan describes the cries as becoming well differentiated during this period, although she describes no test of the judgment of the observer such as used by Dr. Sherman in the Chicago Lying-in and Wesley Memorial Hospitals. She also describes conditioned behavior during the first days of life.

One infant, the seventeenth of this series, had every appearance of intelligently demanding attention as a pleasure satisfaction and knowing when it was granted. From birth it was an unusually pretty baby and consequently was fondled, by some of the nurses, more often than any of the other babies. By the sixth day it was noted in the nursery that this baby cried frequently when neither hungry nor wet and that the cry would cease immediately when and during the time it was fondled, generally taking up the cry as soon as it was put back in the bassinet. The infant seemed in a normal physical condition; so the general conclusion in the nursery was that it desired attention, expressing its desire with a cry and showed satisfaction and content when this desire was granted. This tendency was well developed by the sixth day. . . . The first cry may be entirely reflex but thereafter it very soon has the appearance of learning and of functioning as the expression of desire as well as emotion.[2]

[1] Shinn, Millicent, *The Biography of a Baby*, chaps. III, IV, by permission of, and arrangement with, Houghton Mifflin Company, 1900.

[2] Bryan, Edith S., Variations in Responses of Infants during the First Ten Days of Postnatal Life, *Child Development*, March, 1930.

It might be pertinent to correlate a technical definition of "desire" with

Miss Bryan relates that infants as young as three days would cease crying on being lifted out of bed before their wants had been given attention. Hungry babies when lifted up and placed back in their baskets would remain quiet with wide-open eyes for a time in apparent expectation of "the completion of the satisfaction of their wants which as such could only be ascribed to learning."

Miss Bryan's observations show that the eyes of new-born infants react to light within the first 5 days, and while an occasional infant will fixate a light or bright or white surface for a period of time, the average infant does not follow a point of light with its eyes during the first 10 days.

She says that the average new-born infant gives evidence of hearing between the third and seventh days, although not all respond to whistle and bell until after the first week. "Some infants give the appearance of listening to ordinary talking or crooning before the tenth day."

Miss Bryan verifies the plantar (of the sole of the foot), grasping, and other reflexes as described by various observers, also head-lifting and turning and other motor responses.

On the twenty-fifth day Miss Shinn's niece, while lying contentedly on her grandmother's knees staring at her grandmother's face, turned her attention to Miss Shinn's face when brought near, turned her eyes from one to the other several times and then deliberately turned her head far back in order better to observe the light reflected from the lamp upon Miss Shinn's shoulder, her face manifesting what Miss Shinn describes as "a sort of dim and rudimentary eagerness; . . . she no longer stared but really looked." She thinks this achievement indicates definite training in control of eye muscles in space and direction, and says this is "a great deal for a baby to have learned in three weeks; still, babies have to learn fast if they are ever to catch up with the race."[1]

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an inventory of the infant's mental and emotional equipment at this age. The writer is of the opinion that Miss Bryan has been betrayed into the traditional interpretation of this phenomenon, which would seem rather to indicate the need of further study as to the effect of excessive stimulation upon the primitive behavior mechanism.

[1] SHINN, *op. cit.*, pp. 66–68.

The day after the child was one month old Miss Shinn tested her with a lighted candle and records that she followed it when it was moved slowly, and turned her head far backward to follow it.

Miss Shinn noticed an "awakening look, an access of attention, wonder, or intelligence" on the face of the baby at about the close of the first month of development, which indicated to her that a marked step in development had occurred. She advises all observers of infant behavior to watch for this significant sign. She remarks that Preyer observed the same manifestations in his child at about the same age.

Miss Shinn also records that about this time the baby seemed to become aware of the difference between companionship and solitude.

> In the latter days of the first month she would lie contentedly in the room with people near by, but would fret if left alone. But by the end of the month she was apt to fret when she was laid down on a chair or lounge, and to become content only when taken into the lap. This was not yet distinct memory and desire, but it showed that associations of pleasure had been formed with the lap, and that she felt a vague discomfort in the absence of these.
>
> Just before she was a month old came an advance in hearing. So far this sense had remained little more than a capacity for being startled or made restless by harsh sounds. I had tested it on the twenty-third day, and found that the baby scarcely noticed the sound of an ordinary call bell unless it was struck within about six inches of her ear, and suddenly and sharply at that; and on the twenty-sixth day she showed no sign of hearing single notes of the piano, struck close to her, from the highest to the lowest. But the next day, at the sound of chords, strongly struck, she hushed when fretting with hunger, and listened quietly for five minutes—her first pleasant experience through the sense of hearing. . . .
>
> Only a few days later, when she was a month old, I thought that her pleasure in companionship was increased if she was talked and crooned to; and it is likely that by this time, though she had not hitherto noticed voices, she was beginning to get them associated with the human face. . . .
>
> The first smile that I could conscientiously record occurred the day before the baby was a month old, and it was provoked by the touch of a finger on her lip; and a day or two later she smiled repeatedly at touches on her lip. The day before she was a month old, also, when

her lips were brought up to the nipple, she laid hold upon it with them—the first seizing of any sort, for her hands were still in their original helplessness, waving vaguely about at the will of the nerve currents.[1]

Preyer records that his child followed a moving object with its eyes on the twenty-third day, and Dearborn says that his child followed a slowly moving desk candle with both eyes and head at thirteen days.[2] He says that on the fifteenth day his baby sucked her thumb when it came into accidental contact with her mouth, but was unable to replace it in her mouth after it was forcibly removed. Dearborn's child is somewhat precocious as compared with other biographical records of infant development, although following a similar developmental sequence. He records deliberate visual pursuit of moving objects at eighteen days and apparent recognition of approaching bottle at twenty-two days.

Dr. Charlotte Bühler, who made very detailed observations of young children in Vienna lying-in hospitals and orphanages, classifies early behavior as negative and positive or as flight and defense. All of these children seem particularly to object to the daily cleaning of the nose. Dr. Bühler says that the month-old child "throws head back when satiated or when senses are stimulated. Bends back and makes restless movements of the head."[3]

She reports that crying, during the first half-year, is "always closely connected with movement," that at the start it is "highly undifferentiated behavior," and that modifications in the crying sounds can be observed from the second month on, thus implying agreement with Sherman's observations as to the character of the crying of early life.

Irwin says:

Vocal sounds frequently are components of mass activity. That is to say, new-born infants under ten days rarely make a sound unless it

[1] Shinn, *op. cit.*, pp. 71–74.

[2] Dearborn, George, V. M., *The First Three Years of a Child,* Motor-sensory Development, Warwick-York, Inc., 1910.

[3] Bühler, Charlotte, *The First Year of Life,* pp. 23–25, John Day Company, Inc., 1930.

is accompanied by overt body activity. The only exception seems to be faint throat sounds such as gurgling. Crying accompanies mass activity. In the adult, crying is generally limited to certain muscle groups of the thoracic, throat, and mouth regions. In the new-born, as has been suggested, when crying occurs the head rolls, the mouth is opened wide, the body twists, jerks, bends, and is thrown about, the arms slash, and the legs kick. It is therefore suggested that crying probably is a component of mass activity.[1]

The Viennese children are said to turn repeatedly toward a bright light only when two or three months old. The same is reported as to the beginning of active listening and touching. This is later than with the children described by American observers. Dr. Bühler records that staring, turning head toward breast, opening mouth when lips are touched and withdrawal from bottle with ejection of nipple when satiated are usual month-old reactions.

Neonatal Training.—As we consider the achievements of our month-old infant we are impressed with the fact that he is "learning." Out of the undifferentiated blur, which James called "blooming, buzzing confusion," which the organismic school calls the "matrix" or "ground" of consciousness, the baby has come to be aware of the "qualities" of light and sound and mass; and of comfort in the way of softness, warmth, and freedom of movement. He has begun to react to total situations such as the bringing of his bottle or being picked up for nursing or changing of a wet diaper, and to sense a vague, general satisfaction in the bodily contact and nearness of a protective human being, and shows agreeable response to change of position.

In the light of the contributions of biological research to our understanding of child development we can imagine we see corresponding increments of growth extending infinitesimal but important contacts between nerve and brain mechanisms.

The very common observation that infants of a few days or few weeks of age cease crying when picked up and apparently "cry to be taken up," needs further careful research. It is not consistent with the accepted descriptions of the brain and nerve development of the infant at this age to assign to him deliberate

[1] IRWIN, *op. cit.*, p. 68.

purposeful action involving complex cerebral associative memory. The more rational assumption would be that the infant is more comfortable in arms than he is when lying down, and it would seem to be more rational to try to find out why he prefers arms to his bed, rather than to enter into disciplinary conflict with him at this tender age. Since not all, and probably only relatively few, infants do show this particular behavior reaction, it seems reasonable to assume that the fault lies in the situation and the management rather than in the planned behavior or innate perversity of the child. Watson and many other writers on child management assume that the infant has become "conditioned" to his mother's arms and "established a habit" of being taken up. If this be true we still have to determine why he wanted to form this habit. Response to warmth and softness is not the entire reason, for the child stops crying when he is lifted but not fondled, and the arms in question may be less soft than his bed. Fatigue, muscle tire, irritation from clothing, restricted movement, and nervous irritability from too much handling are often factors in the situation. The fact that the infant who is normally vigorous, whose food and feeding intervals agree with him, who has not been subjected to excessive and unnecessary handling, and whose movements are not hampered, seldom manifests this behavior problem, should make us loath to adopt the "let-him-cry-it-out" policy. There certainly should be a very careful and minute study of each total situation with an attempt at better adjustment to the physiological needs of the particular child. This study should also include careful research to determine the actual effect of prolonged crying and discomfort upon the plastic nervous structures of the young infant.

Adjustment to a schedule is the major training problem of the neonatal period. It is a matter of observation that a normal infant will accommodate himself to any regular schedule of feeding and care which provides for his physiological needs and renders him comfortable. This is the reason babies formerly thrived on 2-hour feeding schedules and now thrive on 3- and 4-hour schedules, largely at the caprice and preference of the attending physician. The baby will obligingly learn to start his day at 6 or at 7 A. M. to suit the convenience of the family, pro-

viding the rest of his schedule is so adjusted that he is made comfortable during the rest of the 24 hours.

The first item of training therefore is the adaptation of schedule to baby and baby to schedule. This is easy or difficult in the first place according to how well the schedule does meet the needs of the child and how regularly and consistently the nurse and mother carry it out.

The adjustment of the schedule to the babe requires nicety of judgment and intelligent observation on the part of both physician and attendant. If conditions are correct as to warmth, quiet, bodily freedom, and good air, the normal infant will adjust to his feeding schedule within a few days if the schedule meets his needs. Continued crying on the part of a neonatal infant should not be ignored. The fact that many infants survive prolonged periods of active protest against conditions does not justify the assumption that "it is the nature of babies to cry," and that it will do him no harm to cry, or the still more dangerous assertion that "it is good for them to cry."

It was stated in standard baby books a few years ago that after making certain that pins did not prick and that the baby was dry, he should be left to cry it out providing he did not cry for "longer than one to two hours at a time." This is not only inexcusable cruelty but presents the possibility of serious neglect of conditions which escape recognition by the untrained parent.

It cannot be stated too emphatically that babies do not cry continuously "for exercise." Young parents are in the right when they take the baby's crying seriously and demand that the doctor find and remove the cause. The common attitude of nonchalance on the part of the pediatrician is sometimes a defensive reaction born of his ignorance of the reasons why babies cry, also of his observation that usually they survive, and that the causes, whatever they are, tend eventually to disappear spontaneously. Very frequently, the cause of early crying is the fact that the food is not satisfactory as to quality or quantity. One infant who had cried continuously for 6 weeks went to sleep as soon as the second pediatrician, called by the exhausted parents, had merely filled his stomach by adding a supplementary bottle to the breast feeding, and he was a contented child from that hour. It is impossible to know, at the present time, just

what are the effects of prolonged crying upon the development of the immature nervous system of the infant, but it is safe to say that it cannot be salutary, and one cannot but suspect that it may have a lasting effect in that it may determine basic conditioning or organization of habit patterns.

The adjustment of the feeding schedule is then of primary importance in the habit formation, conditioning, nervous organization, in short, the *training* of the new-born child. Nutrition is his outstanding need for the growth and completion of his body, including his brain and nervous system. There is some evidence that Nature protects the nerve structures by withdrawing selectively from the blood stream the necessary factors for the formation of the nucleoproteins and other constituents of the nervous mechanism. The brain and nervous system are the last to show structural disintegration during most types of malnutrition and food shortage. This does not mean that functional impairment and developmental retardation or distortion may not result from metabolic imbalance, or that this may not react unfavorably upon the mental and emotional organization of behavior.

Apart from food, the neonatal infant needs quiet, body warmth, and especially bodily freedom. The transition from the uterus to the conditions of the world should not be too abrupt. The intelligent nurse or mother will try to "follow the lead" of the child's behavior and provide him with quiet and softness and warmth for his body during the days in which he is going along with very much his prenatal program. He should be handled with gentleness and carefully protected from artificial stimulation and unnecessary handling.

There are individual differences among infants in responses made during the first ten days. In some cases responses expected on the second day do not appear even by the tenth day. For some infants the sucking movements are slowly established and only by reinforcement of the lip stimulation. Other things being equal such as nutritional state, freedom from physical defects and infections, and external conditions, it would seem that differences in structure of the organism, including the nervous structure, would determine such variations from expected behavior. . . . The early formation of habits, by gradual selection from the characteristic diffuse activity of the infant of specific

responses to particular situations, is shown by the majority of the studies. The implication of these findings for guidance in child development merits special consideration.[1]

Bodily Freedom.—One of the difficulties in the usual management of early infancy is the failure to realize the importance of complete bodily freedom. This is important not only from the standpoint of physical development and hygiene, but is even more important from the standpoint of mental development. The nervous mechanism of the infant can express its growth only through muscular activity. The observations which are being made of the early behavior of infants *invest every movement with significance.* As associative paths are completed new groups of movements and new coordinations become possible. These create an inner urge for expression or use of the constantly developing mechanism of behavior. Therefore the clothing of the child and the arrangement of his bed should permit the fullest freedom of movement from the hour of his birth and during every hour of his life. Before he is able to turn himself the baby should be turned from side to side occasionally. If he has freedom to kick and move his arms freely he will attend to his own activity needs and develop coordination with perfect precision, and systems of artificial exercise will become entirely superfluous. Much restlessness doubtless is due to thwarting of this inner developmental urge for activity. The nice point is for the mother to determine whether the cause of restlessness is this internal urge or external irritation. Perfect freedom is often the answer to both difficulties.

Buford Johnson confirms this reasoning:

> Growth in structure determines in part the possibilities of response. The rôle of the frequency and variety of responses that will be made in the environment that permits and encourages them is an important factor often neglected. There are individual differences among infants in rate of growth of organism and in responsiveness to environmental factors. A particular child should not be urged to make responses at a definite age. He should be observed for determination of his environmental needs with reference to the sequence of movements that lead to specific behavior patterns.[2]

[1] JOHNSON, BUFORD, *Child Psychology,* pp. 120–121, Charles C. Thomas Publishing Company, 1932.

[2] *Ibid.,* p. 123.

Summary.—The neonatal infant must adapt to his world; these adaptations are relatively intensive and rapid although they involve, essentially, a very simple setting. Adaptation to environment must occur whether controlled or haphazard, and this constitutes training and determines future conduct.

Since the infant is helpless and incompletely developed, a burden of responsibility falls upon those who control the experience of the new-born infant. Observation convinces us that his adjustment should be gradual and that at first he should have conditions approximating the warmth, softness, and quiet of his mother's womb. His first adjustment must be to food. This is critical; all subsequent development, and in a real sense subsequent behavior patterns, depend upon early and successful adjustment to food routine.

The subsequent experience of the child should be regulated by the obvious development of sight, hearing, and other senses and as indicated by his movements or activity. The infant, even at one month of age, needs variety of experience; he needs to be quietly exposed to variations in light, sound, and touch, but these stimuli should be those normal to the environment in which he is to live and must not be overexciting. Even at one month of age our child is very much a personality and he is already definitely educated, trained, and adjusted for good or ill.

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CHAPTER XXIX

EARLY INFANCY: ONE TO TEN MONTHS

I am so sorry for babies
The poor little gabies!
They always are being caressed
And dressed and undressed
And diapered, stockinged, and sandaled
And handled and dandled
And lifted or put into bed
And forcibly fed
And having their character soured
By being bescoured
And poked into, polished, and scrubbed
And endlessly tubbed.

And then they are barked at and booed at
And mewed at and cooed at
And asked where and which are their toes,
How some animal "goes"
And suchlike ridiculous questions
That spoil their digestions
And ruin whatever remains
Of their infantile brains.

They're worried to smile "just for Fanny"
Or Auntie or Granny
And pinched and wrong-ended and squeezed
And fiendishly teased.
Their privacy isn't protected
Nor ever respected,
For folks are invited to peep
And see them asleep!

No ifs, buts, perhapses, or maybes—
I'm sorry for babies.

ARTHUR GUITERMAN.[1]

Patterns of Behavior.—"In spite of its inexhaustible complexity and variability, the developmental stream of early human behavior is so ordered by biological laws that it may be sys-

[1] Sympathy for Babies, reprinted by special permission of the author and *Ladies' Home Journal*, copyright 1929, Curtis Publishing Company.

tematically studied. There is indeed no such thing as utter randomness even in the behavior of the sprawling infant. The more closely his very sprawling is studied, the more pattern it assumes. . . . The random activity of the four-weeks-old infant is distinctive from that of an eight-weeks-old infant."[1]

The large group of genetic scientists who are observing young children are investing infancy with new and tremendous interest. It becomes a fascinating thing to be the parents of a child and watch the orderly unfolding of a genetic pattern which has been in the process of creation ever since there was life upon the earth.

Doctor Gesell calls attention to the various aspects of pattern in the development of the child. One may observe an *isolated* pattern of special behavior such as winking the eye at quick approach of light; a little later one becomes aware that the winking of the eyes has become *correlated* with withdrawal of the head and, still later, with a defensive movement of the head. Simple patterns or configurations are ever merging into larger patterns. The *duration* of a behavior pattern in an infant becomes significant, for example, the time during which the infant grasps with the whole hand before thumb-and-finger approximation appears may be an index of precocity or retardation. By means of these observations estimates of the *maturity* of the behaving mechanism become possible. Theoretically, it becomes possible to map the nervous system, showing just how far anatomical development has progressed. Actually, Doctor Coghill has done this with Amblystoma. It will probably be a long time before this becomes fully possible with the human infant. In our mind's eye, only, may we see the particular increment of myelination, or the extension of nerve fiber which closes the particular circuit giving the child control of his thumb as a separate mechanism.

The *genetic* significance in any child of these behavior patterns becomes apparent when they are compared with the unfolding behavior patterns of other children and other individuals of his kind. It is thus, for example, that an understanding of language development in general becomes possible. Finally, the study of the precisely ordered pattern of the child's development reveals

[1] *The Foundations of Experimental Psychology*, chap. XVI, The Individual in Infancy, by Arnold Gesell, Clark University Press, 1929.

the fact that he, himself, has an *individual organic pattern* and also that he belongs to a "superpattern" of racial and social organization. Gesell calls this the *biogenetic pattern.*

Gesell has designated the first 40 weeks of life as the *perception-prehension* period, or the period during which maturation of the coordinating mechanism proceeds to a degree of efficiency such that precise coordination is possible between cortex, eye, and hand. He regards this as a significant landmark in development. On pages 638–640, will be found the normative summaries for the first 10 months.



Fig. 113.—At two months a child makes facial response to social approach.

One is impressed, on reading the various biographies of individual babies, with the similarity in sequence and age in the behavior responses as compared with the normative summaries here listed, also with the equally obvious fact that no two are exactly alike. Miss Shinn[1] records that her niece, up to six weeks, had made no sounds other than the dismal, monotonous cry of the first day, an inarticulate fretting, and a sharp cry when startled. At six weeks, cooing murmurs, gurgles, and tiny shouts and various vocal experiments began. At eight weeks, she stared for some 15 minutes at Miss Shinn, turning her head, as her mother handled her, so she would not lose sight of her aunt's face. She then turned her attention in the same determined manner to her mother's face, then turned from one to the other as if comparing them. About this time she would turn her head to look for something out of sight, clearly an act of associative memory.

When near her third month the baby "was possessed by the most insatiate impulse to be up where she could see," fretting

[1] Shinn, Millicent, *op. cit.*, Houghton Mifflin Company, 1900.

and wailing when forced to lie down. During her third month she seemed to discover the difference between grasping her own hand with the mouth and grasping the breast or other substance "not her." She became able to bring hand to mouth although she then grasped it with her mouth rather than put it into her mouth. She grasped objects accidentally encountered and conveyed them to her mouth, but did not look at them until near the end of the third month. She moved hands, arms, and legs a great deal.

At twelve weeks she first recognized her grandfather's face with a joyous cry. Miss Shinn thinks his white beard, shining



FIG. 114.—Four-and-a-half months: struggling up.

head, and eyeglasses made him more obvious to her than was her mother's face. At three months her language included panting, murmuring, babbling, chuckling, shouting, and crowing. She turned her head in refusal or dislike. On the day she was three months old she tried 25 times, with scarcely a pause, to raise herself into a sitting position, striving and straining until red in the face; she now loved to sit propped with pillows, and vigorously resented lying down.

During the fourth month she spent a great deal of time simply looking, and fretted to be carried around so that she might see new objects. "Always with a look of surprise and eagerness, eyes wide and brows raised."[1] She was not so active or so noisy

[1] *Ibid.*, p. 117.

as she was during the previous month. She was enjoying a new-found world of visual images.

Miss Shinn thinks she "had not at all learned the bounds of her own body"; she knew it only by chance touches, and had little control below her arms. If her body was touched she did not look to see what had touched it. She did not reach purposefully for objects. It was during her fourteenth week that she seemed to discover a connection between the sight and the feeling of an object in her hands. She then soon began to grasp at things upon which her eyes rested.

Miss Shinn relates at length the active interest of her niece in her surroundings. She seemed to insist on making the acquaintance of her environment and became quiescent only when fully satisfied with her exploration of a familiar room. During her fifth month she seemed to be stimulated by a strange room, looking about with evident eagerness and curiosity, a seeming desire to penetrate the unknown. As her range of vision increased she followed the movements of persons.

She became charmingly responsive, smiling and crowing, and several times laughed out loud when played with boisterously. She was free from fear or nervous excitement and loved a frolic in which she would be "tossed, rolled over, or slid down one's knee."

The baby spent much of her fourth month sitting in a horse-collar (the traditional method of teaching farm babies to sit alone) playing with her rattle and actively waving her arms.

It was during this month that she first showed signs of fear: once of a strange woman in a large hat, once at an abrupt movement of her father, and several times she waked up and cried in the dark at night when her mother did not come immediately to her.

She was busy during this period making experimental sounds. "She would lie looking earnestly at me, draw her breath, gather her lips into shape, and finally explode the sound with a great expenditure of breath." Also a "note of real desire, unheard before, appeared in her voice."[1]

During the fifth month she entered suddenly "the era of handling things." Miss Shinn describes the "swift four days

[1] *Ibid.*, pp. 137, 139.

in which the baby came into realization of her powers of using hands and eyes together." One is reminded of Coghill's Amblystoma when it abruptly became able to swim and to walk (see page 457). "In a few days she had become a different baby,



FIG. 115.—Five months. Grasps a dangling ring.

with a new world of interests, and a wonderfully more varied and vivid life."[1]

She rapidly learned to distinguish between flat surfaces, such as pictures, and objects which she could grasp (at nine months she had an amusing experience in trying to grasp the *shadow* of a moving rope).

[1] *Ibid.*, pp. 141, 146, 153.

Miss Shinn wisely advocates a wide variety of experience at all times as indicated by development. "Certainly the wider liberty of holding and handling he [the child] can by any device be allowed, the better; the instinct is very strong, and wholly healthy, and the thwarting of normal instincts is not good for any one's nerves or mind."[1]



FIG. 116.—Six months old and already finding this a rather jolly world.

During her sixth month she began to notice that objects fall, and then to watch them falling. She began to imitate clapping or spatting movements; to try to creep when placed upon her face; she investigated the parts of her body; showed recognition of vocalization addressed to her. Her sense of localization

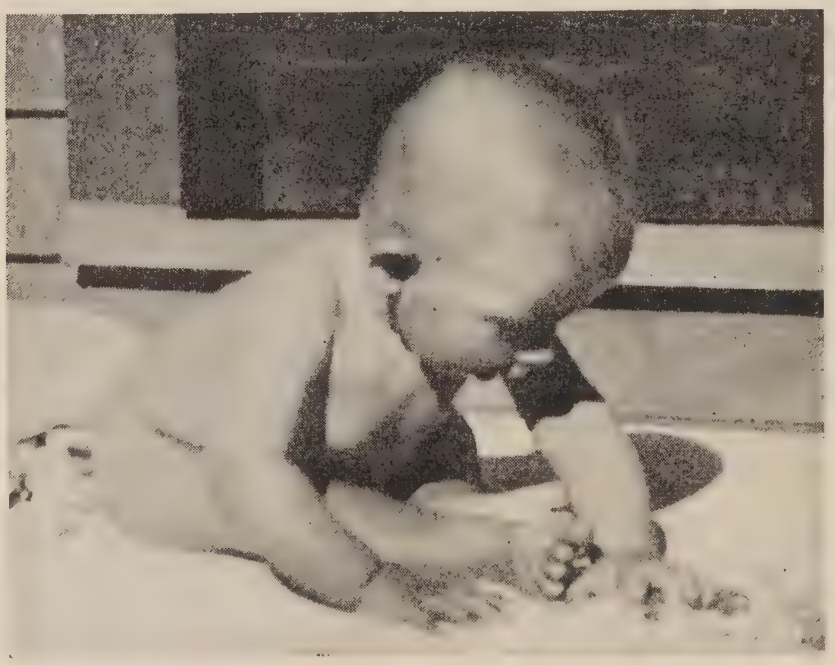
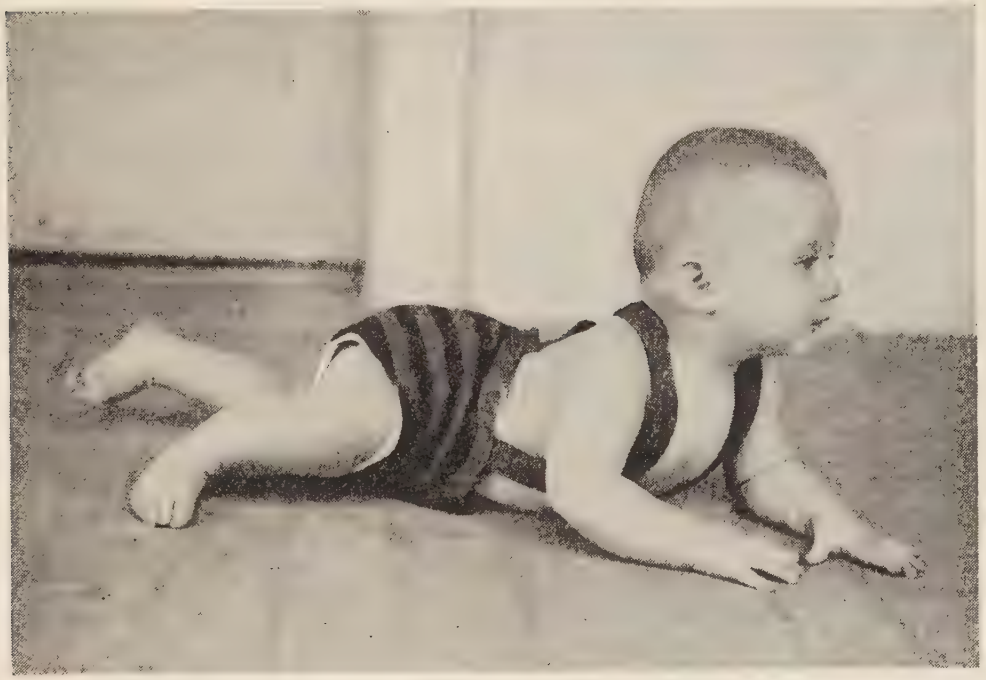


FIG. 117.—Seven months old. Sitting quite securely and grasping with whole hand.

developed rapidly, and she watched with great concentration the movements of others, such as the entire process of

[1] *Ibid.*, p. 155.

setting a table, resenting any interruption of her prolonged inspection.



(*a*)



(*b*)

FIG. 118.—Seven and one-half months. (*a*) I see the cat. (*b*) I'll go after it.

She cried long and continuously during a prolonged absence of her mother. She was easily frightened by strangers, but was delighted at the sight of the large shaggy family dog, greeting

him with a "cry of desire" one day when she seemed suddenly to become aware of him for the first time. "No person or thing had ever interested her so much."

At seven months she began to romp rowdyishly, clutching at hair and faces and laughing loudly. She learned to associate names with persons, her favorite "grandpa" first. During this month she learned to wave "by-by."

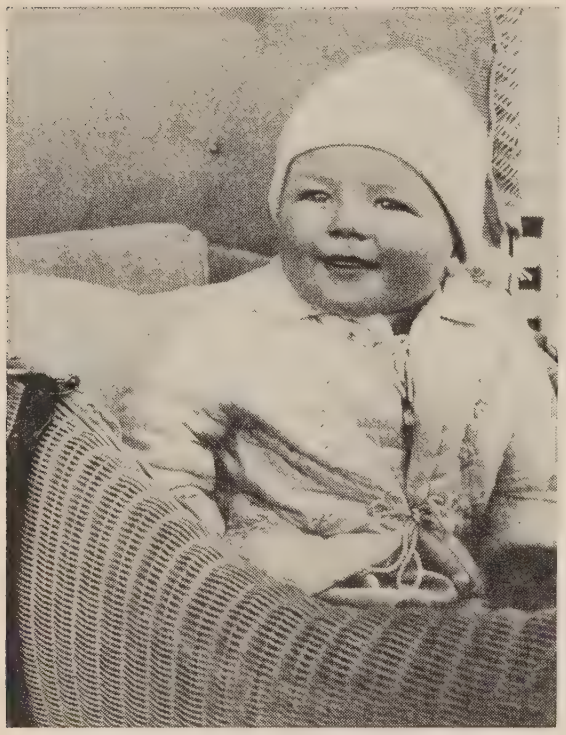


FIG. 119.—Seven and one-half months old and ready for anything!

During the eighth month she acquired "pat-a-cake" and other accomplishments and learned to inhibit a few movements at "no-no."

During her ninth month she crept freely and rapidly and taught herself to stand alone, "by diligent self-training." There was great increase in the little one's mental alertness, her eager curiosity in following movements, her look of effort to understand, her growing clearness in grouping associations and interpreting what she saw.

Her handling of things had long developed into elaborate investigation, turning an object over and examining every side, poking her fingers into crevices, opening and shutting lids, turning over the leaves of books; and now she was no longer satisfied with investigating such objects as she came across by chance—she began to have a passion (which increased for weeks and months, and long made up a great part of her life) to go and find what there was to see. She crept to the window and stood at the low sill, to look out, beating the pane with her soft little hands and laughing in an ecstasy of delight if the dog wandered by. She crept into the hall and explored it, sitting down in each corner to take a survey, and to look up the walls above her. Her toys were neglected; she was impatient of being held in arms, and eager only to get to the floor and use her new powers. She crept happily about for hours from chair to chair, from person to person, getting to her feet at each, and setting herself cleverly down again; smiling and crowing at each success, and coming to us for applause and caresses. . . .

Outdoors her happiness was even greater than in the month before, and her cries of rapture as she looked up, down, and around, and realized her own activity in the midst of all the waving and shining and blooming things, were remarkable—uttered, as it were, from the very deeps of her little soul, with that impassioned straining of the central muscles by which a baby throws such abandon of longing or ecstasy into his voice. . . .

The sights and sounds of out of doors now contributed greatly to the little girl's joy there. She had for some weeks noticed sounds more than ever before—the tapping of a woodpecker, for instance, or the stamping of a horse in the stable—and now she was quick to look and listen at the note of a bird. She watched the birds, too, for the first time, as they flew from tree to tree; and the profuse California flowers were objects of incessant desire and pleasure.

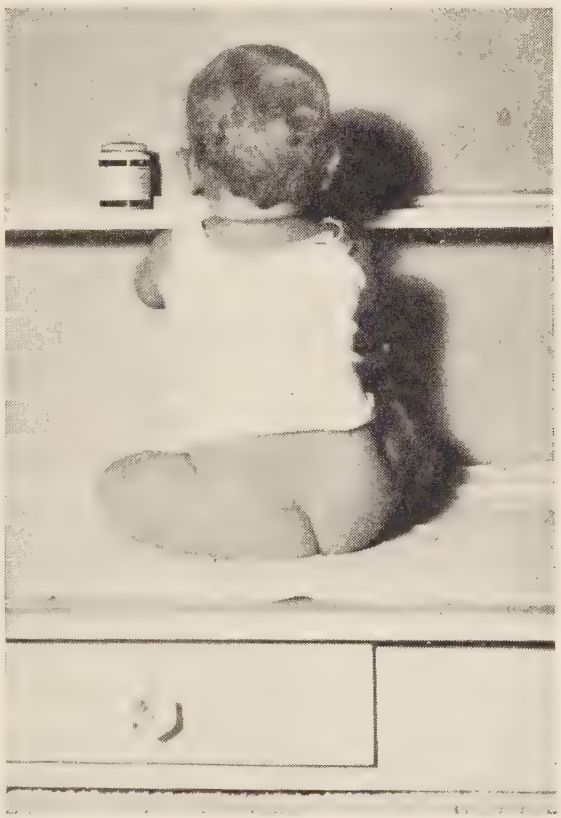


FIG. 120.—Nine months old. The greed to explore.

The power of communication was considerably increased in this month by the acquisition of one exceedingly useful sign. The way in which it was developed is an interesting example of the evolution of such signs. First the baby began to use her forefinger tip for specially close investigations; at the same time she had a habit of stretching out her hand towards any object that interested her—by association, no doubt, with touching and seizing movements. Combining these two habits, she began to hold her forefinger separate from the others when she thus threw out her hand towards an interesting object; then, in the second week of the month, she directed this finger alone towards what interested her; and by the third week, the gesture of pointing was fairly in use. She pointed to the woodshed door, with her mewing cry, when she wished to see the kittens; to the garden door, with pleading sounds, when she wished to be taken thither; to the special bush from which she wished a rose. She pointed in answer, instead of merely looking, when we asked, "Where is grandpa?" "Where is Muzhik?" [the dog]. . . .

All this time she had shown no great improvement in walking movements when held from above, and she had no particular ambition to walk. But in the last week of the month [ninth] she began to edge along by the side of a chair, holding to it—a great advance.

The first attempts at climbing, too, appeared before she was quite ten months old. In the third week of the tenth month the baby had let herself down by her hands quite cleverly from a large chair in which she had been scrambling about—a feat that must have been quite instinctive, since she did it well and easily at the first try. The last day of the month, as she hovered at the foot of the stairs (a region about which she had much unsatisfied curiosity), some one helped her to put her knee on the lower step. Thereupon she laid hold on the next one, and pulled herself up, and with the same help, mounted two steps more. . . . A candle was set on a higher step as a lure, and, sure enough, the little thing, unaided, set her knee on the higher level, laid hold with her hands, and drew herself up. It is significant that true climbing movements should be so early and so easily caught at a single partial lesson [these observations were made some 30 years ago, before the rise of the maturation concept.][1]

At the close of the ninth month this little girl was "pouring out strings of meaningless syllables, with marvelous inflections and changes," with the faint suggestion of purposeful repetition of certain syllables such as dă, dă, etc.

Dr. Charlotte Bühler presents an interesting analysis of her observations of a number of children during their first year. She says that a turning point occurs between the second and third months marked by playful experimenting; the first active response to position; the first coordination of two senses acting simultaneously; the first social reactions and expressional movements, all indicating that the "passivity" of the newborn has been replaced by "receptive interest." The child pays attention to his own movements and sounds.

Between five and six months another turning point occurs, marked by continuity and concentration of effort and attention; the first sure grasping; an active seeking for stimuli, instead of merely reacting to experiences which happen to come to him.

Dr. Bühler, like Gesell, thinks the tenth month a turning point, but the behavior phenomenon which seems to her sig-

[1] *Ibid.*, pp. 217–222.

nificant is the purposeful use of tones and syllables, *the dawn of communication.*[1]

Dr. Karl Bühler divides the first year into periods of (*a*) instincts, (*b*) training, and (*c*) intellect. The first period of *instinctive* behavior occupies the first six months, while he observes the first signs of what he is pleased to call intellect at about ten months, (again the ten-months turning point). He designates the last quarter of the first year as the "chimpanzee age," a period during which the child exhibits about the level of behavior of certain of Köhler's apes as described in *Mentality of Apes.*[2] The period of *training* during which the child, according to Dr. Bühler, "learns" to use his legs, hands, eyes, etc., stretches somewhat indefinitely between the periods of pure instinct and the first appearance of purposive thinking.[3]

Emotional Development.—Lovisa Wagoner says, "The goal of emotional training is the development of a rich and deep emotional life which finds expression in ways that are acceptable both to the individual and to the group."[4] The infant at birth shows passivity, aggressiveness, and withdrawal. If the head is forcibly held, the arms move more vigorously than the legs. If the legs are held, the effort at withdrawal is more vigorous in the legs than in the arms. In both instances the movement spreads to the entire body. In the case described by Watson of lowering the infant in water, violent slashing and struggling of all parts of the body occurred (see chap. XXVI).

Lashley, Cannon, and others have shown that animals when decerebrated (having the cerebrum removed) and idiot children born without cerebra show manifestations of rage and fear. This leads us to surmise that the early behavior of the infant is largely directed by the autonomic and subcortical centers.

[1] Bühler, Dr. Charlotte, *The First Year of Life*, chap. XII, The Stages of Development, John Day Company, Inc., 1930.

[2] Köhler, Wolfgang, *The Mentality of Apes*, Harcourt, Brace & Company, 1926; Morgan, John J. B.: *Child Psychology*, p. 31, Richard H. Smith, 1931.

[3] Bühler, Dr. Karl, *Mental Development of the Child*, chap. II, The First Year of Life, Harcourt, Brace & Company, 1930.

[4] Wagoner, Lovisa C., *The Development of Learning in Young Children*, chap. IX, p. 148, Mastery of the Emotions, McGraw-Hill Book Company, Inc., 1933.

Pleasurable stimuli, such as patting or feeding, produce general relaxation with a lessening of muscle tension. Sherman thinks the faint smiling of very young infants may be due to relaxation of the facial muscles. He says, "the particular form of the emotional response is determined by the adjustment which is made. Stimuli demanding retreat become associated with fear, those requiring aggressive behavior with anger, and those requiring passivity with love. Thus the specific emotions which become typical for an individual arise out of social usage and through experience develop as habitual methods of reaction."[1]

Sherman believes that the habitual emotional "set" of the individual may be determined in infancy. He describes two types of infants seen in hospital practice: the ward infant who does not have a private nurse, who is handled very little except for feeding, clothing, and bathing, and who is allowed to cry until it becomes quiet. This child is quiet, rarely cries, and demands little attention. On the other hand, the infant who has a private nurse, is shown to visitors, picked up and soothed by patting or stroking when it cries, soon demands attention, and develops "emotional responses which persist throughout infancy and childhood."

The primitive emotions are the phylogenetic, protective emotions of fear and rage. Some investigators, notably Watson and his group, think they have seen evidence of these very soon after birth. Others are equally positive that there is no evidence of any inborn or instinctive specific emotional responses. The Ohio group states that in the tests performed by them, infants rolled tightly in cloth, or with nostrils held shut may calmly go to sleep and that only 1 to 2 per cent show any defensive reactions.[2] It is probable that the methods of the various investigators have varied sufficiently to invalidate comparison of results. Doubtless continued observations will result in some approach to agreement

[1] Sherman, Mandel and Irene Case, *The Process of Human Behavior*, chap. VI, p. 157, The Nature of the Emotions, W. W. Norton & Company, Inc., 1929.

This suggests the James-Lange theory of emotion, which said that we are sad because we weep, and fear because we run. Many psychologists now believe that this places the cart before the horse.

[2] Pratt, Nelson, and Sun, *The Behavior of the New-born Infant*, pp. 176, 179, Ohio University Press, 1930.

as to technique and conclusions. As far as practical training is concerned it matters little whether these emotional reactions are inborn or acquired with early experience, or whether, as favored by the writer, we regard these as unfolding, inborn patterns which may be definitely conditioned by experience. Miss Shinn, who did not subject her niece to experiment, observed the first evidence of fright a few days after she was one month of age. This was caused by the clashing of the handles on her tin bath while she was half asleep. She started violently and cried loudly, and did not quiet down entirely for five minutes. This was something different from the reflex starting at sudden noises which had occurred since the first week; this could not be explained on a strictly physical basis, since the violence of the stimulation of the organ of hearing could not be conceived to persist for so long a period of time as the crying lasted.[1]

If we think of the child as a maturing organism which must, as a matter of survival, integrate with his environment, and if we consider that integration implies the formation of associations, wholes, units of relatedness, Gestalten, involving few or many of the aspects of living, we may account for emotions rather simply.

Maturation creates an urge for use, expression, action, which becomes a goal.[2] Restraint or prevention of normal organic activity is unnatural and stimulates protective and defensive responses such as withdrawal and muscular activity in resistance as seen in extreme stimulation even in the new-born. With the progress of maturation this simple primitive reaction of resistance becomes correlated with glandular, cerebellar, and cortical activity and may become finely coordinated into purposeful action patterns such as trained fighting, fencing, shooting with firearms, etc.

The more frequently situations arise making a goal of resistance to restraint, and thwarting (which may be physical or purely psychic), the more resentment and resistance reactions will

[1] SHINN, *op. cit.*, p. 81.

[2] Seashore says: "Man has an instinct to do everything that he can do. The possession of capacity carries with it the tendency to use that capacity; with the possession of wings goes the capacity to fly, with the possession of the capacity for reflection goes the tendency to reason" (*Psychology in Daily Life*, chap. X, Play, D. Appleton-Century Company, 1913).

become habitual—temporary gradients of cortical response will become permanent gradients.

One of the lessons of life is learning that one must accept certain restraints. This is the whole of what we term discipline. It has been suggested many times in these pages that the infant should learn at once to accept certain restraints upon his freedom, such as being placed at the breast at certain intervals, being placed upon a vessel for bowel movement, having his thumb withdrawn from his mouth. Some would add his acceptance of long periods of inactivity in his bed at the convenience of his mother. Consideration of his normal activity needs such as those described by Miss Shinn makes us less certain of this.

Disciplines such as accommodation to regular health habits can usually be managed without arousing the anger reaction. As the child develops, however, the need for activity and expression increases, together with the infant's inability to express his need otherwise than by energetic attempts to do the sort of thing he is ready to do, and opportunity for conflict becomes frequent. When the child has an inner urge to bang and throw he becomes enraged if the spoon and ball are taken away from him. If none are given to him, he may become simply fretful and difficult because of thwarted urge for activity. When he becomes interested in his surroundings and wants to view his environment from a sitting position, or, better still, from being carried about in some one's arms, has he not a right to rage when he finds himself thrown upon his back, tucked in, and strapped in, with nothing but a canopy or a ceiling upon which to practice his new coordinations of vision and touch?

When he discovers the stairs, and is found (so unexpectedly!) when nine or ten months old to have climbed up several steps, gleeful and crowing over his accomplishments, he has a right to kick and scream if snatched up rudely, insulted by "no, no," if not a spat, from some elder who does not understand. While the urge to perform this particular stunt is in the ascendancy, he will make himself a safe climber if he is permitted to do so, especially if a goal in the form of a toy or a lighted candle is put at the foot of the stairs, and the baby acquires a "complete experience" the first time, by being encouraged to come down. He learns that going up and coming down belong together.

Few occasions arise in which it is desirable or necessary to thwart the natural activity of any child. *It is the mother's business to give him safe and convenient opportunity to do the kind of thing which he wants to do.* As we have seen, even before ten months the child has many and varied needs for activity. Continually to thwart these is to retard mental and physical development and elicit frequent anger reactions. An unhappy distorted personality may be established even at this tender age.

The emotion of fear is expressed in the withdrawal reaction of the newborn. The first instinct is withdrawal from pain. If the stimulus is repeated, resistance follows.

Both fear and anger result from situations with which the organism is unable to cope. These are patterned or instinctive reactions which seem to be present at birth in the simple forms of withdrawal and resistance and which should become conditioned into permanent habits of caution and proper aggressiveness, without ever passing through the unpleasant intermediate stages of definite fear and rage.

It seems probable that particular fears are determined by the experience of the child. "A burned child dreads the fire." The infant who has had a painful or jarring fall fears withdrawal of support. An infant whose ears have been hurt by sharp sounds fears loud noises.

While fear of the dark is not instinctive, and many children entirely escape this experience, yet Miss Shinn records that her niece did seem afraid of the dark for a time when only a few months old. One wonders what may be the sensations of an infant who has just come into the conscious enjoyment of vision on fully awakening in the dark and being unable to see. May it not be a sensation of thwarting equivalent to having the eyes held shut?

Agreeable emotions (the "tender emotion" or "love") in the young child are called forth by sensuous physical comfort, softness, patting, stroking, caressing, kissing. A good deal has been written by the Freudians and behaviorists about the undesirability of conditioning the habits and behavior of the child around these emotions. Much of this discussion appears to the configurationist to be distorted and extravagant in emphasis. The worst indictment against excessive caressing and handling of

the infant is that it tends to center the child's interest and attention upon his bodily sensations rather than upon doing and accomplishing. As the child grows older he is confronted with the necessity of accommodating to the affection of his elders rather than to the general conditions of a normal environment. He comes to evaluate his conduct in the light of approval or disapproval on their part instead of judging his acts according to their origin and effect.

Most parents would think that the behaviorist goes too far who says: "Never hug and kiss them, never let them sit in your lap. If you must, kiss them once on the forehead when they say good night. Shake hands with them in the morning."

This severely formal attitude, however, is less harmful than the other extreme of sentimentality one often sees in the parent or nurse who smothers the soft, adorable infant with insanitary, bacteriologically horrifying kisses, and who cannot resist constantly handling the helpless victim. Such an adult is himself emotionally unstable and will distort the personality of any child. If we can keep the fact in mind that we do not wish to have this child think about his bodily sensations in one way or another, rather we wish him to be interested in the world around him, and in establishing a normal relatedness to the people and things with which he must have increasing dealings, it will be quite clear that he has little need for emotions other than the pure joy of being healthily alive and active; and that we should try to bring him to the ten-month milestone with as little acquaintance as possible with fear, rage, or love. We would not, however, deprive any child of the sense of security and joy to be found only "within the encircling arms" of parental love. Tenderness, a feeling of unique closeness, a sureness of understanding, are every child's right; these inhere in the parental relationship. These are not to be confused with the erotic, possessive sentimentality discussed above.

Buford Johnson says, "The warnings to parents concerning the evils of display of affection to children have resulted primarily from studies of unadjusted adults. There is serious danger in withholding from children those reactions which mean for the child a genuine regard for him. . . . The affection displayed by his parents for him is a major factor in his adjustments. . . . Dis-

play of affection should be given with the primary purpose of manifesting the affection and not as rewards or as motivations of an act."[1]

Certainly the child should not be conditioned emotionally to experiences with which he is not developmentally mature enough to cope. A child at eight months may retain a lasting fear of stairs if he accidentally creeps off a landing and receives a painful bump. A month or two later, when actively interested in exploiting the stairs, he will take many bumps when hands and knees slip, but will not be frightened and will pay surprisingly little attention to the hurt.

The supreme emotion of life is seldom mentioned in discussion of the emotional life of the young child, and that is the joy of action, so delightfully pictured by Miss Shinn. The infant's cup of happiness runneth over when he achieves the use of a new set of coordinations—learns a new trick. This is the joy of achievement, the supreme motivation of life. *This emotion we should foster in the child at every step in his growth;* through it he will conquer fear and rage by becoming able to cope with the conditions producing them; through it he will protect himself from devastating excess of the "tender emotion."

The urge to do, achieve, calls into function, as cortical development proceeds, the tools of accomplishment which we designate as imitation, curiosity, imagination. We have seen the impulse already appear in our ten-months-old child to imitate simple patterns of motor behavior such as waving by-by, and playing peek-a-boo. Miss Shinn describes a "satiable curiosity" in her niece for exploring her environment.

In fact our child has developed at a faster rate and learned more than he will in any remaining similar interval of his life. He has a personality, and has acquired habit patterns which may change little during the rest of his life.

Training in Early Infancy.—We have seen that definite adaptation to environment occurs during even the neonatal month of life. By the tenth month very pronounced shaping of habits and personality has come to pass. The child has acquired habits of eating, sleeping, and elimination which determine in

[1] JOHNSON, BUFORD, *Child Psychology*, chap. IX, Emotion, p. 363, Charles C. Thomas Publishing Company, 1932.

large measure his physical growth, his health, his nervous poise, and his comfort. All of these affect his emotional reaction and behavior. He has achieved a degree of motor coordination commensurate with the maturing of his nervous system, and this has been affected to some degree by his opportunities to exercise and experiment with his abilities.

The first problem of the parent becomes that of recognition of developmental progress and providing opportunity for exercise and experience without overstimulation or premature stimulation of the immature mechanism. This involves also wise conditioning of behavior units as they come into function; that is, conditioning bowel and bladder action, food response, fear response, etc. It must never be forgotten that the behavior mechanism matures by units or systems and not by uniform, generalized development.

The futility of anticipating maturation is illustrated by the research observations of Dr. Arnold Gesell and Dr. Helen Thompson, of the Yale Psycho-Clinic, in their work with identical twins. The "control" twin was found by these observers to perform an act (such as climbing steps) spontaneously, when maturation created the inner urge, with efficiency practically equal to that of the "trained" twin who had been carefully and persistently drilled in the performance in advance of full maturation of the internal configuration.[1]

The second problem of training becomes that of providing situations such that the child can secure *complete experiences, configurations, wholes, or Gestalten.* The organismic scientist believes that the essential scheme of growth and behavior in all organisms involves the realization of symmetry and completedness in so far as conditions will admit of completion. It is probable that in child rearing the greatest deterrent to normal mental development and to normal emotional satisfaction and balance is the fragmentary character of the child's experience occasioned by the parent's failure to recognize the "goals" created by the infant's developmental progression. For example, the infant between eight and ten months becomes interested in

[1] Gesell, and Thompson, Learning and Growth in Identical Infant Twins, *Genetic Society Monographs*, July, 1929.

throwing and banging. This marks the linking and coordination of the reflex mechanism involved in making these movements with cortical centers which are just coming into use. The child *needs* to throw and bang in order to develop the big throwing muscles, he needs to throw and bang in order to acquire precision of control of these fundamentally important coordinations. These specific urges to action become goals. Under the conditions of internal stimulation occasioned by the chemistry of growth these movements become paths of "least action." When the child wants to throw and bang he should be given an abundance of safe and appropriate opportunity to perform these acts until he is completely satiated, or has achieved his goal, completed his experience, or whatever term we may wish to apply to this phenomenon. This completion will be indicated usually by the fading of interest, and the rise of other goals, or inner developmental urges, such as standing, creeping, walking, manipulation of objects, etc.

The child who is not given opportunity to throw and bang during the period of ascendancy of this urge, or who is baffled and thwarted in his efforts in this direction[1] will lack an important unit of training and experience and surely will not be quite normally symmetrical and rounded in his mental and physical growth. An account is given in *Child Development Abstracts*[2] of a child whose hands were tied to prevent self-injury after circumcision, and later during illness to prevent scratching, and finally, habitually tied at night until he was six years old. The child failed to develop normally in mind until given freedom of motor activity, whereupon he developed mentally with rapidity. His mind could only express itself through physical activity.

[1] One young father tried to "train" his nine-months-old son not to throw a spoon given to him while sitting in his high chair, by picking up and returning the spoon each time and at the same time spatting the baby's hands. The natural result was to "condition" the child in fear of his father, since the obvious association was between the spatting and the father rather than between the spatting and the throwing; and the bewildered father finally retreated and put the spoon out of the reach of the justly enraged and baffled baby.

[2] Vol. 5, No. 5, October, 1931, 1002, from Hill and Robinson, *British Journal of Medical Psychology*, vol. 10, 1930.

Even during these first ten short months of life many opportunities arise for the application of these very fundamental principles. As has been stated repeatedly, the earliest configurations or habits have to do with physiological functions which are controlled by the vegetative or autonomic nervous system. As the cerebral cortex becomes integrated with the behavior mechanism, conscious or aggressive activity appears in the general sequences indicated in Gesell's normative summaries of behavior. *Each phase of behavior is significant.* Each new act is significant.

When the infant becomes able to distinguish form and light and movement in objects he needs a wider and more varied environment than during the neonatal period when he is merely digesting, sleeping, and maturing his machinery of behavior. When he becomes able to lift his head he should be given frequent opportunity to exercise his head, neck, shoulder, and arm-muscles. He should be placed in a variety of positions and attitudes during his wide-awake hours; all done quietly, gently, and without jerking or excitement.[1] The infant needs only to be quietly exposed to his normal environment and given an opportunity to adjust to it, and the activities of the home need not be adjusted in any radical manner to the child.

When imitative behavior appears, the parent is given an enormously important tool for training. When the child reaches for the spoon and wants to try to feed himself, he should be assisted and encouraged in the effort. This will normally come at about the time the throwing, reaching, banging coordinations have brought his big muscles under cortical control, which is immediately followed or overlapped by the appearance and coordination of the grasping and picking movements, and all correlated with sitting up. When the infant can both reach and grasp with some degree of accuracy and mental control, he is equipped both to imitate and to initiate a limitless variety of activities. For this reason Dr. Gesell considers this complex achievement to be a landmark in development.

[1] It may be appropriate here to say a word of disapproval of the way many persons approach an infant. They raise the voice, laugh in a loud and excited manner, and poke, jab, and grimace at the helpless infant and, all too frequently, tickle, juggle, and otherwise try to stimulate laughter and emotional response from him. This is artificial, overstimulating, and altogether pernicious.

It is important to recognize the appearance of the imitative urge and expose the child to opportunities to imitate appropriate acts, and conversely to protect him from acquiring undesirable action patterns or configurations because of exposure to undesirable stimulation. An example of the latter is afforded by the frequent practice of young fathers of boxing with the infant, often beginning during the banging period. The baby soon learns to strike back with great glee, and father and baby enjoy romps of this character, innocent at the time, but apt to set a pattern of behavior which may be difficult to recondition later.

The classic by-by, pat-a-cake, little-pig-went-to-market, and peek-a-boo imitation plays are good, but should be used judiciously. No infant should be stimulated to "show off," and no infant should be surrendered to the mercies of visitors, relatives, or strangers, to be subjected to inappropriate, exciting, and fatiguing manipulations and play.

It is important to stress these points with reference to this period of development because it is the infant from six to ten months who is most likely to be used as a plaything, during the period in which he is becoming so delightfully aware of his human associates, and so fascinatingly responsive to social approach. It is easy to forget that he needs time and quietness in which to make adjustments to the new world of awareness. A very good rule in making the acquaintance of infants and young children is to permit them to make the advances. Attention should never be forced or urged upon a child of any age. Children who are used as playthings and thoughtlessly exploited to minister to adult amusement and parental pride often begin to acquire defensive reactions even before the age of ten months, and show shyness toward strangers, cry easily, and show other signs of unfortunately conditioned behavior.

The infant should have a play pen from the time he can sit alone. He should be placed in it, for short intervals at first, during his most active periods of wakefulness. The play pen should never become a prison in which the baby is incarcerated for the mother's convenience (see Fig. 68).

A study should be made of the playthings most liked and used by the baby, and the mother must expect to provide new employ-

ment constantly if the child is to be given opportunity to use his developing machinery of behavior.

Play Equipment for Early Infancy.—In general, articles of the normal environment should be used as occupational material, as far as easily possible or appropriate. The child enjoys these quite as much as he does special commercial playthings, and he is at the same time learning to know and use his environment. First playthings (and later ones as well) should be durable and easily cleaned. During this period when everything goes into the mouth, sterilizing the playthings should be a daily rite.

Playthings should be appropriate to the level of maturity; first, things to chew, such as ivory or rubber rings or disks; next, things to throw and bang, rattles, table spoons, balls, etc., when he sits alone, anything and everything of such size and weight that he can handle and manipulate it. Especially should he be permitted to satisfy his curiosity about anything and everything he sees and wants to explore. The only way in which he can learn weight, distance, color, texture, fragility is through experience. "No, no" may condition an unusually plastic child not to interfere with the mother's convenience, but "no, no" is not educational. More often "no, no," used as a principal tool of training, creates an attitude of rebellion and resistance.

The child who is permitted to handle breakable objects under careful supervision can be taught to handle them with care, and *carefulness becomes a goal of achievement of interest to him.*

"Stop" or some such command should be set apart and used *only when prompt obedience is actually necessary for the safety of the child, as when he is going into immediate danger.* It should be used so seldom and with such emphasis that obedience is assured. He should never be made to feel that exploring and learning is a crime. If he pulls over a plant, breaks the pot, spills the dirt, and wrecks the flower, it is not necessary to spat his hands and scold in order to prevent recurrence. Discussion of the event in conversational tones and simple words, holding the attention of the creeping infant to the process of cleaning up, the regretful tone "too bad, no flower, dirty floor," etc., will be more apt to prevent recurrence than angry tones, spatted hands, and a conditioned child who has learned, chiefly, to explore when no one is looking, *since explore he must.*

One advantage in using spoons, cups, bottles, etc., as playthings is that the child learns correct names and acquires familiarity with usable objects.

During the period of active picking up things and putting them in the mouth, great care must be taken that the baby does not get hold of objects of swallowable size. He may have strings of buttons, safety pins, and beads if very securely fastened.

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CHAPTER XXX

LATER INFANCY

LANGUAGE-LOCOMOTION PERIOD: TEN MONTHS TO TWO YEARS

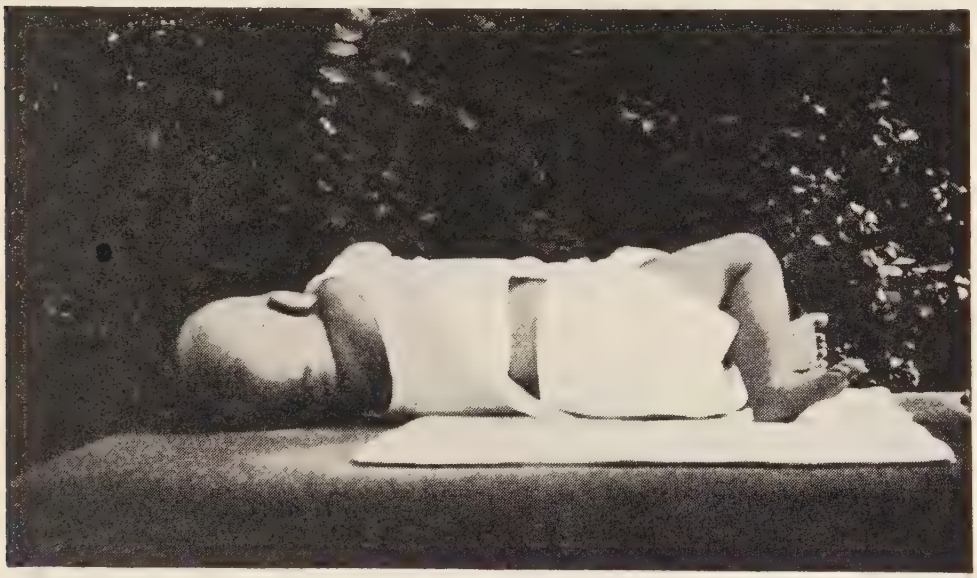
Hold childhood in reverence, and do not be in any hurry to judge it for good or ill. . . . Give nature time to work before you take over her task, lest you interfere with her method. . . . A child ill taught is further from virtue than a child who has learned nothing at all.—J. J. Rousseau, *Emile*, 1762.

We have now seen our child arrive at a stage of development which has made him keenly aware of a world outside of himself. He has become aware of sound, light, color, form, density, and space. He has discovered his mechanism of locomotion; he can touch, and talk, he can cause things to move; he can explore, discover—*learn*. He can by consciously modifying his vocalization obtain response from others. He is full of the urge to experiment and to explore. He especially wants to touch, feel, lift, handle, manipulate. He also coordinates these tactile sensations with taste and smell and sound. His centers of association and coordination are connecting up with each other rapidly. His sensory mechanism is becoming integrated into a functional unity. He has become aware of others and delightfully responsive. Out of his original helplessness and passivity an aggressive and assertive personality emerges. It becomes our pleasant duty to watch the further transition of our infant into childhood as he perfects the tools of *locomotion* and *speech*.

Locomotion.—According to Gesell's normative summary for twelve months, the normal infant not only pulls himself up from a sitting to a standing position, but walks with help. At fifteen months he stands and walks alone; at eighteen months he climbs a chair; at twenty-one months, walks backward and walks attended on the street, and at twenty-four months runs (see normative summaries, Appendix C). Maturation, notably of

the cerebellum, determines rate and sequence of locomotive norms.[1]

Miss Shirley reports that the 25 babies included in her study[2] exhibited individual characteristics in walking, subtle differences in the stepping habit and characteristic ways of placing the feet, pointing the toes or curling them under, or patting one foot on the other. The feet of the infants were oiled and the prints they made upon strips of white paper were dusted with lamp-



(*a*)

FIG. 121.—The story of locomotion. (*a*) Four and one-half months: rolling over.

black. The observers became able to identify many records by reason of individual characteristics.

She reports a wide variation in the ages at which these children walked. The most precocious child could walk when led at twenty-three weeks; the most retarded at seventy-two weeks. The median age of walking when led was forty-two weeks. The

[1] The cerebellum grows very slowly in the first five months, then suddenly it begins to develop faster, until finally it attains its greatest rate of growth in the last half of the first and the first half of the second year, reaching its full size toward the end of the fourth year. The time at which its greatest increase is indicated, at the end of the first year, is also the time when the child is learning to sit and to walk—activities requiring the effective regulaton of bodily equilibrium which the cerebellum supplies" (KOFFKA, KURT, *The Growth of the Mind*, p. 59, Harcourt, Brace & Company, 1927).

[2] SHIRLEY, MARY M., *The First Two Years*, vol. 1, *Postural and Locomotor Development*, p. 82, The University of Minnesota Press, 1931.

age of walking alone varied from fifty to seventy-six weeks with a median of sixty-four weeks.



(*b*)



(*c*) (*d*)

FIG. 121.—The story of locomotion, *Continued.* (*b*) Seven months: hands and knees. (*c*) Nine months: stands with support. (*d*) Twelve months: an anxious moment. Balances with arms.

Perfection of skill in walking alone was attained at sixty-four to ninety weeks. From this time on improvement was a matter of speed and accuracy. Miss Shirley says that the infants settled down between eighteen and twenty-four months to a rather

uniform rate of about 170 foot prints per minute covering a distance limit of about 30 meters. Three women, as controls, walking briskly, covered, respectively, 42, 48, and 49 meters



(*e*) (*f*)

(*g*) (*h*)

FIG. 121.—The story of locomotion, *Continued.* (*e*) Twelve months: less anxious but still needs arms. (*f*) Thirteen months: arms coming down. (*g*) Fifteen months: exploring the universe. (*h*) Eighteen months: Quite the man!

and took 145, 142, and 143 steps per minute. This indicates that the child moves more rapidly but covers only three-fourths the distance covered by his mother. In proportion to his leg length the child probably takes longer steps than the adult.

These findings indicate that the adult in walking with a child should always permit the child to walk at his own natural speed and never (as one frequently sees) pull him along by an arm and force him to assume an unnatural gait.

The stepping angle assumed by these children varied at first. Most of the infants "toed out" when they first began to stand and walk. Only two infants were consistently pigeontoed throughout the period. Most of the infants tended to reduce the stepping angle to zero and toe straight ahead by the age of two years.



FIG. 122.—A precocious one-year-old. Walking well upon her first birthday.

Miss Shirley reports that the small, wiry children tended to walk earlier and better than those who were shorter and heavier. Martin, a child of the wiry type, "jumped on his toes" at twenty-seven weeks of age, completely skipped the stage of standing with help, and at twenty-nine weeks walked across the room, with help, in 30 seconds. By thirty-five weeks of age he was not only walking well but was stopping on his way to investigate toys. He was walking alone at fifty weeks of age and walking rapidly at fifty-four weeks.

On the other hand, Torey, who was heavy, with short legs and small feet, showed no interest in standing or walking and occasioned much anxiety by his refusal. At seventy-two weeks of age, however, he suddenly walked without help for the first time and almost ran. At the age of seventy-four weeks he was walking well.

Miss Shirley states that a fair prediction of the walking age may be made by doubling the age at which the infant sits alone. She sees some evidence, not yet conclusive, that the proportionate length of leg enters into the matter of walking, since the first four babies to achieve a leg-trunk ratio of 0.60 or more were also

among the first to walk, while the last four babies to achieve this ratio walked very late.

Since the children appearing in this experiment were all presumably healthy and were all permitted perfect freedom, the differences shown would seem to represent differences in rate and completeness of organic development. Miss Shirley interprets her findings on the basis of the maturation hypothesis. She says:

> The sudden appearance of integrated locomotor skills that the babies apparently had never practiced is in accordance with the development of locomotion in Amblystoma [Coghill]. The law of integration first and individuation into reflexes later probably applies to babies as well as to lower vertebrates. . . . Coghill's interpretation is in perfect agreement with these observations.[1]
>
> . . . . .
>
> There is orderliness in the development of a particular motor skill; creeping, sitting, and standing all have their patterns. Because it follows a pattern, motor development meets the requirements of the maturation hypothesis. . . . Training and conditioning unquestionably play a rôle in motor development, but their rôle is subservient to maturation and inborn trends.[2]

Miss Shirley was able to discover no coordination between the use of the arms and hands in prehension as described during the period of early infancy, and the ability of the child to walk. She says the use of the hands and arms in reaching is a different matter from maintenance of postural control and locomotion.

Burnside made a photographic study of the early locomotion of a series of children and found a wide variety of hitching, pulling, crawling, and creeping movements. She concludes that the infant goes through a period of experimental movements and that early environmental conditions may determine the specific locomotion action-pattern.[3]

A good many psychologists ascribe importance to motor development and locomotion as an index to mental capacity. Terman found that the average age for walking in average normal children is about 0.8 month older than that for gifted children,

[1] Shirley, *op. cit.*, p. 191.

[2] *Ibid.*, pp. 172, 180.

[3] Burnside, L. H., Coordination in the Locomotion of Infants, *Genetic Psychology Monographs*, vol. 2, 1927.

while feeble-minded children are almost 12 months later than normal children in walking. Miss Shirley, however, was unable to find any coordination between motor development and mentality with this group of healthy well-cared-for babies.[1] She thinks locomotor precocity offers a far from satisfactory clue to intellectual precocity, although a "small but positive relationship" was shown to exist between motor and intellectual skills when these children were subjected to the Minnesota intelligence tests for eighteen months.[2]

Motor Play.—Miss Shirley observed and classified the motor play of her test children by periods corresponding closely to Gesell's normative periods. At the close of early infancy the child is struggling to his feet and learning to use his arms and hands. Miss Shirley says, "play was still activity per se." As soon, however, "as the baby could move about under his own steam his activity became directed toward a goal and was not indulged in exclusively for its own sake."[3] When the child in the learning-to-walk period really wants to get somewhere he usually drops down and creeps. He is a persistent climber at this age. He climbs up into chairs and goes up the stairs on hands and knees. He climbs the leg of an adult who holds him by the hands, a gleeful game all babies seem to enjoy. Kiddy-cars and walkers are used and abused at this period. The tendency of apparatus of this sort is to lead the child to excessive use and activity of legs and feet while entirely inhibiting corresponding developmental exercise of the arm and shoulder girdle. The child should climb and pull and push to his heart's content. Thus only can he develop a symmetrical body, equally strong and useful in all its parts.

Babies at this age love to shove chairs and movable articles of furniture. Before a child can walk alone it can propel its buggy along the street, holding onto the handle. At from fifteen to eighteen months of age the child learns to come down the full flight of stairs. He now uses the stairs purposefully, to get somewhere rather than for the pure joy of exercise. He climbs down from furniture; he soon begins to run; he loves a chase; he learns

[1] Shirley, *op. cit.*, p. 172.
[2] *Ibid.*, p. 134.
[3] *Ibid.*, p. 140.

to use chairs as tools on which to climb for something out of reach.

Imitative motor play develops steadily during the entire period of later infancy. We saw that the child at ten months has begun to play pat-a-cake and by-by. He adds to his repertory as opportunity affords until by two years he is entering with spirit into many make-believe games and tries to dress himself, sweep the floor, and do many things he sees others do.

That new levels of behavior are made possible by the completion or closure of new circuits within the nervous system is illustrated by "spurts" of activity. "For weeks at a time a child remained at a standstill, and suddenly within a day's time he had climbed the next step and was functioning on an entirely different motor level."[1]

Language Development.—Gesell gives the normative summaries for language during the later infancy period as follows: At twelve months says two words; adjusts to simple verbal commissions; places cube in or over cup on command. At fifteen months says four words and uses expressive jargon. At eighteen months says five or more words; uses jargon conversationally; points to nose, eyes, or hair. At twenty-one months joins two words in speech; names one picture; repeates things said. At twenty-four months names three of five objects; points to five objects on a card; uses words in combination.[2]

Miss Shinn records of her niece that in the middle of her fifth month she seemed to imitate the movement of her mother's lips when she said "papa!" Miss Shinn thinks this was the beginning of discrimination in articulate sounds. She began at about this time to hold out her arms and make expressive whimpering, coaxing sounds addressed obviously directly to the person whom she wished to take her up. Miss Shinn thinks this was not so much the beginning of human language as it was of the language "the baby shares with all beasts and birds."[3]

A month later the baby began to "pour out long, varied successions of babbling sounds, which expressed content, interest, or

[1] SHIRLEY, *op. cit.*, p. 173.

[2] GESELL, ARNOLD, *Infancy and Human Growth*, pp. 132–134, The Macmillan Company, 1928.

[3] SHINN, *op. cit.*, p. 159.

complaint very clearly." In the latter part of the sixth month the baby "would coax for a frolic by leaning forward with an urgent 'Oo! oo! and expressive movements of her body." If she wished something else, to be taken up or given an object, "there were small but quite definite differences in tone, expression, and movement, so that we usually knew at once which she meant."[1] At about this time she began to show signs of recognition when her name was spoken. During her seventh month she seemed to begin to connect the name with the person in the case of members of her family and seemed to have some idea of the meaning of "No, no!"

It was during her eleventh month, however, that consistent repetition of certain sounds occurred. She chattered more than ever in expressive jargon, but out of the random matrix of sound syllables appeared. "Da!" was suspiciously often ejaculated when she threw out her hand in pointing. "Na-na-na!" separated itself out as a wail of protest, and "Ma-ma-ma!" seemed a whimper of discontent and loneliness. During the month Miss Shinn is sure the baby associated the word "gone" or "all gone" with disappearance. She would make various sounds such as "Gng," "Ng-gng," and finally achieved "Gong." This word meant all manner of disappearance. She used it when she dropped something; when her food went down her throat; when she felt the bald spot on her father's head; when she slipped off a step. Twice before her first birthday the baby turned and looked into Miss Shinn's face when some one left the room and said "Gong!" At other times she seemed to say it as if stating a fact to herself rather than as if imparting information. Miss Shinn's comment is of interest in its seeming anticipation of the configuration theory.

> Even when there is plainly an idea as in All gone, it is a big, vague blur of an idea, slowly taking form in the little mind, as the blurs of light and dark slowly outlined themselves into objects before the little eyes months before.[2]

During the last days of her first year she began to exclaim "By" and "My." The only other word she acquired during

[1] Shinn, *op. cit.*, pp. 169, 175–176, 229.
[2] *Ibid.*, p. 229.

her first year was "Kha!" This sound, expressive of disgust, was addressed to her when she put her fingers into food and such situations. She soon used it in its correct connection, although her disgust was imitative rather than real, as she still continued her digital explorations!

Although her definite vocabulary was limited to the above exclamatory sounds, for her real talking

> she used a wonderfully vivid and delicate language of grunts, and cries, and movements. . . . It was remarkable what shades of approval and disapproval, assent, denial, and request she could make perfectly clear.[1]

The baby's understanding of speech far exceeded her use of words. Miss Shinn says she knew at one year, by accurate test, "51 names of people and things; 28 action words which she proved she understood by obeying" commands and requests, "and a few adverbial expressions like 'where' and 'all gone'—84 words in all, securely associated with ideas."[2]

During the twelfth month she learned to nod in assent, and to say "E" in approval, possibly an attempt at "Yes." She had also a definite negative grunt.

During this month she learned to recognize the letter "O" on her cards, and Miss Shinn says she picked up the other letters of the alphabet rapidly and easily.

Margaret Curti describes the origin of speech thus:

> Simple movements, then, including cries or vocalizations, early become significant in making possible communication with and "control of" adults. As gestures, they may be said to represent the first stage in the development of language, although to the infant himself they have no symbolic meaning.[3]

Mrs. Curti says that the process by which sounds and gestures acquire symbolic meaning is deeply significant in the development of the child.

> During the first half-year we may observe in infants the spontaneous making of simple sounds, first almost purely vowel sounds, such as ă

[1] Shinn, *op. cit.*, p. 237.

[2] *Ibid.*, p. 236.

[3] Curti, Margaret Wooster, *Child Psychology*, pp. 190–191, Longmans, Green & Co., 1931.

and ä sometimes aspirated (hä or ah) or nasalized (an); later, especially after the third month, various vowel-consonant combinations, as mă, gä, ăng; and finally vowels with labials and fricatives, making such sounds as păp, ŭv, and the like. These sounds apparently occur in an order determined roughly by growth of the finer laryngeal and other muscles. . . . A part of the general random reflex activity of the infant,

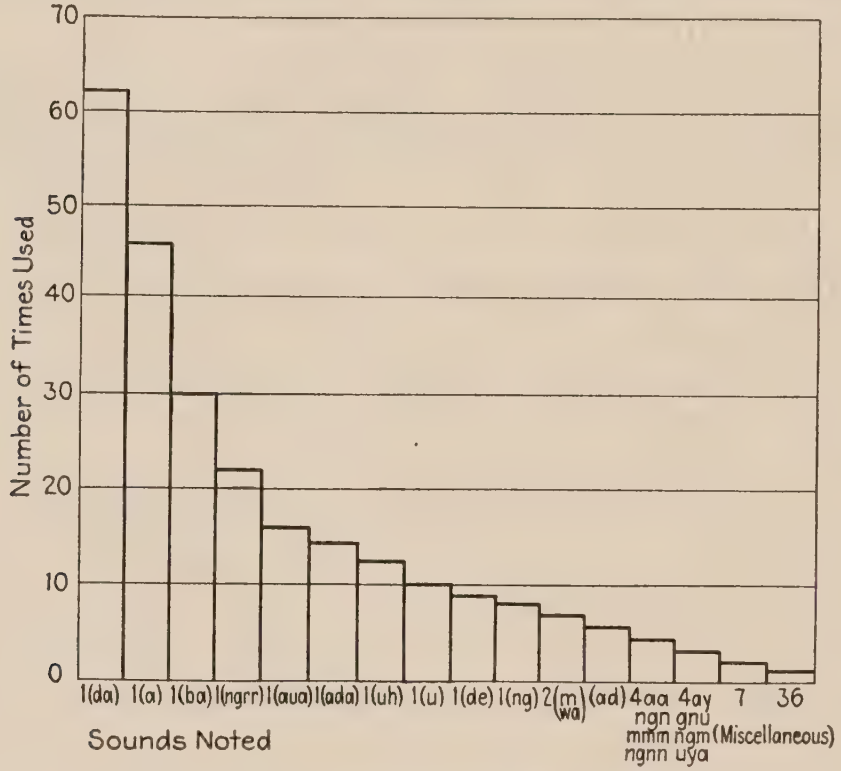


Fig. 123.—Vocalization chart of I. M., age six months. Sixty-four different sounds were distinguished and their frequency is shown in the diagram. (*From Gesell, The Mental Growth of the Pre-school Child, The Macmillan Company.*)

they are called out by intraorganic stimuli, and are connected with a general state of bodily well-being and organic tonicity. These speech sounds are to be contrasted with the sharper cries or noises which are definitely emotional in character.[1]

L. M. Malmbery of Gesell's staff recorded as completely as possible all the sounds uttered by one child during 24 hours. Figure 123 shows the result.[2]

Doctor Curti explains speech as a conditioned response.

When a baby articulates a given syllable, for example "da," he is being stimulated by two main groups of stimuli, one the auditory group

[1] Curti, *op. cit.*, p. 191.

[2] Gesell, Arnold, *Mental Growth of the Preschool Child*, p. 216, Fig. 150. The Macmillan Company, 1925.

represented by "da," the other a kinaesthetic-tactual group arising from the responses of the laryngeal, throat, and tongue movements which occur as the word is said. Now with a few chance repetitions of the sound, we have the essentials for the formation of a conditioned response, namely two stimuli affecting the organism at the same time and followed by a common response, the speaking of another "da."[1]

Hearing the sound "da" spoken by others becomes an adequate stimulus to utter "da." He thus practices the sound and develops facility in articulation. Eventually the sound, or some modification of it, comes to include further items in its "condition" or "configuration," da-da may come to denote a certain individual, the father of the child.

Random vocal sounds uttered repeatedly by the child may come to have chance conditioning which escapes the notice of the parent, as when the child persists in saying "na, na" when he wants a drink because his mother chanced to give him a drink when he was practicing this vocal exercise.

Adults may assist the child by repeating to him clearly the sounds he is trying to make. Dr. Curti says the child will not repeat from mere hearing a sound which he has not already used—in other words, for which his vocal mechanism is not ready. It is, therefore, a waste of time to try to "teach" an infant to utter new sounds or words.

It is interesting to reflect that human animals of all races are provided with vocal mechanisms capable of producing similar ranges of sounds. Environment in the form of racial experience has shaped these sounds into equivalent languages which may be translated one into another. Thus a child's language becomes one item of his racial or social inheritance.[2]

Buford Johnson asserts: "All vowel and consonant sounds necessary for speech are made within the first year and sometimes within the first six months."[3]

From attaching sounds to objects as names, the child comes to attach sounds to situations, such as "gone" with disappear-

[1] Curti, *op. cit.*, p. 193.

[2] Wagoner, Lovisa C., *The Development of Learning in Young Children*, chap. XII, Learning to Talk, pp. 182–183, McGraw-Hill Book Company, Inc., 1933.

[3] Johnson, Buford, *Child Psychology*, chap. VI, Speech, p. 193, Charles C. Thomas Publishing Company, 1932.

ance, in the instance of Miss Shinn's niece; or meowing with a cat. Thus action words are added to name words.

Before the child can formulate a sentence one word commonly stands for an entire sentence. "Wa wa" may mean "Give me a drink of water." "Miew" may mean "I want to play with the cat."[1]

Vocabulary Studies.—P. Guillaume, after observing his own child's development of language, reports:

"(1) The child understood simple commands at eight months. (2) The one-word sentence is an undifferentiated word, and cannot be classed into any one part of speech. It may be used as a noun, a gesture forming the verb, or the word may designate the act, a gesture designating the subject. (3) The child's early words are always simplifications of the adult word. (4) The next stage is two "one-word sentences" joined together to express one idea. (5) At the beginning of the second year, true sentences occur. They usually involve the name of a person and an act or the expression of a wish or desire. (6) Vocabulary begins to increase rapidly when the child discovers that everything has a name."

His child used six nouns referring to objects at the age of twelve months and ten days; 11 nouns at thirteen months, twenty-seven days; 26 at fifteen months, thirty days; 68 at eighteen months, six days; 168 at twenty-one months, fifteen days.[2]

John Dewey in 1894 made a vocabulary study of two children at nineteen and eighteen months of age respectively.

He reports that *A*'s [nineteen months] vocabulary contained 60 per cent nouns, 21 per cent verbs, 11 per cent adjectives, 3 per cent adverbs, and 5 per cent interjections. *B*'s [eighteen months] vocabulary contained 53 per cent nouns, 28 per cent verbs, 1 per cent adjectives, 6 per cent adverbs, 5 per cent interjections, 6 per cent pronouns, and 1 per cent conjunctions.[3]

[1] Arlitt, Ada, *Psychology of Infancy and Early Childhood*, chap. XIII, Language, pp. 277–278, McGraw-Hill Book Company, Inc., 1930.

[2] Guillaume, P., "Preschool and Parental Education," *Journal de Psychologie*, vol. 24, 1927 (summarized in the *Twenty-eighth Yearbook of the Society for the Study of Education*, p. 513, Public School Publishing Company, 1929). Quoted by permission of the society.

[3] Dewey, J., The Psychology of Infant Language, *Psychological Review*, vol. 1, 1894 (summarized in *ibid.*, p. 506).

C. H. Cooley reports that the child under his observation understood I and You when used by others at the middle of the nineteenth month.

> Early in the twenty-second month the use of I was imitated with apparent sense of subjective reference. . . . The child first used *baby* as referring to self about the twenty-fourth month.[1]

W. Boyd observed the language development in one child who used its first word at eleven months. There was a large increase in vocabulary between two and three years. There were few pronouns in the two-year-old's speech. Between three and four years personal pronouns were used freely.

> The vocabulary at seventeen months consisted of 117 words, 70 per cent of which were nouns; at two years, of 656 words, with 49 per cent nouns; at three years of 960 words, with 43 per cent nouns; and at four years, of 1,031 words, with 42 per cent nouns.[2]

He notes that at two years the sentences were brief, averaging 3.3 words; the child usually omitted prepositions and conjunctions.[3]

Jessie Chase Fenton says:

> Endless repetition is characteristic of childhood; the performance of any act suggests itself again, and the child finds inherent satisfaction in repeating a sound or a gesture or action of some kind in a monotonous sequence that would drive a grown person to madness. This tendency is first strikingly evidenced in the baby's babbling. But though any given sound may be reiterated indefinitely before it is relinquished, there is nevertheless great richness and variety in the babble as a whole. Usually it contains a far wider range of separate sounds than the child will have use for in later life. Among my baby's first sounds were a number of gutturals not used in English at all, among them the German *ch*, and a harsh throaty *gh:* the German sound of ö and French *eu* occurred frequently, and a considerable number of slurred vowel sounds which I could not set down at all in our alphabet. Together with these occurred in many different combinations nearly all of the sounds used in English, though put together often in combinations

[1] Cooley, C. H., A Study of the Early Use of Self-words by a Child, *Psychological Review*, vol. 15, 1908 (summarized in *ibid.*, p. 504).

[2] Boyd, W., The Development of a Child's Vocabulary, *Pedagogical Seminary*, vol. 21, 1914 (summarized in *ibid.*, p. 500).

[3] Boyd, W., The Beginnings of Syntactical Speech: A Study in Child Linguistics. *Child Study*, vol. 6, 1913 (summarized in *ibid.*, p. 500).

which we never use, such as *dzhi*, *dth*, *ngya*. The sounds of *f* and *v* I did not catch at all during the first year, nor *qu*, though the *k* and *w* sounds of which it is composed were common.[1]

Rand, Sweeny, and Vincent say that vocal skill is developed from random vocalization just as skill in walking develops from random movements.

> At first these sounds seem largely reflex in character, varying over a range of about 12 or 14 vowel and consonant sounds. Within the first eight months, however, the variety of these sounds has been extended so that there are included all the sounds necessary for language; English, Spanish, French, . . . German, and African sounds being recognized by Mrs. Blanton in her study of infants.[2]

Mrs. Fenton says that of the eight words which composed the vocabulary of her child at one year, six had arisen through special application of sounds first used as babble. *Di* often repeated became "*did'n*" or "*dad'n*" and came to have much the same meaning as *gong* with Miss Shinn's niece, except that it seemed to include the motion of dropping or disappearance as well as the phenomenon, as he uttered it at hearing a sneeze, throwing a toy, cramming the last of his cracker into his mouth, etc.

"Tak-kn" (thank you) was achieved in the following manner. The child chanced to hand his mother's purse to a lady saying "Did'n" as he did so. The lady said "thank you" and handed it back. He proceeded to hand the purse to each person in the room in turn, who handed it back, saying "thank you." Before he had completed his rounds his "did'n" has been modified to "tak-kn" which then became a firmly established word in his vocabulary but seemed to mean *giving* rather than *receiving*, since it was the act of giving the purse which stood out most vividly in this particular experience.

A small friend of the author who was addressed with punctilious politeness by the members of her family acquired a corruption of "*please*" as one of her first words. It sounded somewhat like "p-hŭ" spoken explosively. This symbolized desire to her. She would approach her mother, take her by the hand, lead her

[1] Fenton, Jessie Chase, *Psychology of Babyhood*, pp. 122–123, by permission of, and arrangement with, Houghton Mifflin Company.

[2] Rand, Sweeny and Vincent, *op. cit.*, p. 201, W. B. Saunders Company, 1930.

to the sink, point to the faucet and utter her pleading "p-hŭ," repeated until her want was satisfied. When she was thirteen months old her mother was on one occasion clapping her hands and humming a rhythmic tune for Mary Catherine to dance. Her mother stopped abruptly to say something to a friend. Mary Catherine walked up to a third person, performed her little caper, and said earnestly "P-hŭ! p-hŭ!" meaning "please go on with the music, I'm not through."

Mrs. Fenton says:

> A natural spontaneous sound becomes most easily attached to meanings; hence teaching which concerns itself with such sounds will have most effect in stimulating mental development in the matter of associating sounds with meanings.[1]

This seems to confirm the theory of maturation as basic to learning and also the principle that educational effort must follow maturation as evidenced in the spontaneous activity of the child, rather than force or anticipate this.

Mrs. Fenton records that her child first seemed to hear entire sentences as rhythmic configurations of sound before he could distinguish the component words. He would obviously try to repeat these, although at first able only to indicate the rhythm and tone. His "Diz-iz-zee-ee" at bedtime was an unmistakable echo of "This little piggy." He would imitate the accent and inflection of nursery rhymes in jargon without uttering a single word in detail. When he became able to distinguish words and attach meanings to them he stopped trying to say whole sentences.

For months this baby continued to master words, attaching definite meanings to them; then during his twentieth and twenty-first months he had a period of sheer and accelerated imitation, during which he repeated *everything* he heard, apparently for the sheer joy of imitation and exercise of his vocal mechanism. He was much intrigued by telephone conversations, standing behind his mother and repeating the numbers and fragments of conversation accurately.

Mrs. Fenton asserts that words whose meaning is suggested by their sound are favorites with small children. She says her

[1] FENTON, *op. cit.*, pp. 130–131.

son, even when knowing the correct name for an animal, preferred the descriptive word and persisted in calling chickens "chee chee," the cow "moo," the sheep "baa," etc. During his twentieth month he voluntarily began to use the correct names, and produced the sounds made by the respective animals only on request. Like all children, Mrs. Fenton's baby first used one-word sentences such as "Buggy!" meaning "I want to ride" or "Down!" for "I want to walk." He used few verbs up to the middle of his second year. His first long sentence came at the end of eighteen months. "Daddy! Kool! Man! Atto!" uttered when he had seen his father get into an auto with another man and drive away. He paused with each word as if putting the idea together bit by bit.

By the end of his second year he put words together more fluently with less pause and less effort for each word.

Speech Training.—The young child at first *thinks aloud.* He cannot help trying to say the name when he sees the object or the action, or uttering descriptive jargon if he has not yet achieved the word. The transfer from spoken to silent speech is accomplished imperceptibly. At first the mind seems to require expression in speech just as the body requires expression in action. Eventually the child learns to sit still and to keep still. In both instances complete development through action must precede repression and control or there will be retardation of structure and function in body and in mind.

Children should not be urged to repeat difficult or meaningless words. This only encourages the use of words without knowing their meaning. The rôle of the adult is constantly to define and interpret at the desire of the child, and by careful enunciation and repetitions to assist the child in acquiring correct understanding and formation of language. To insist on a child's saying "Thank you" whenever he is handed an object is to attach an irksome and annoying and meaningless connotation to a purely adult convention. Mary Catherine, without ever having been requested or urged to say "please," spontaneously associated the word with the idea of securing what one wants. With her this was a one-word sentence of great satisfactoriness and effectiveness, and she is on the way to becoming an unconsciously courteous child.

No child should be urged to speak. He should be given the widest possible variety of suitable experience; he should be spoken to clearly, always on his level and having his attention. He should be conversed with in words which he can understand, great pains being taken to have each word or sentence convey in some degree its correct meaning to him. For the rest he should be permitted to talk as and when he likes. Word drill, such as "Say dog," not "dă," or withholding a drink to try to force the thirsty baby to say "wa-*ter*" instead of "wah-wah" is sheer folly, and only serves to confuse the poor baby, who is using his vocal apparatus in the only way its immaturity will admit. Protective negativisms may thus be aroused which soon become interpreted as disobedience.

The Origin of Language.—There are several theories as to the origin of language. One is that sounds expressive of emotions such as cries, roars, grunts, groans came to be consciously used as warnings, mating calls, for terrifying, etc. This is the *emotional* theory of the origin of language.

Another is the *onomatopoetic* theory which sees language originate in sounds descriptive of the buzz, hiss, whistle, bleat, etc., of various animals. In either case the sounds became conditioned with situations until eventually the sound became the symbol of the situation.[1]

Doctor Wheeler thinks both gesture and picture preceded (phylogenetically) definite sound language. The pictured language certainly preceded written language—the picture becoming gradually simplified until we have the alphabet.

The transition from vocal to silent speech or silent thinking compels speculation as to the process involved. Dr. Wheeler believes,

> Much of thinking consists of vocal-motor imagery and this imagery involves incipient movement of the speech muscles. The movements can be recorded, and their amplitude varies directly as the definiteness with which the words are imaged. . . . If every performance is executed by the organism-as-a-whole, muscles obviously function to some extent in all kinds of responses.[2]

[1] Wheeler, Raymond H., *The Science of Psychology*, pp. 133–134, Thomas Y. Crowell Publishing Company, 1929.

[2] *Ibid.*, p. 433.

Since language appears to be a matter of social inheritance (see chap. IV), it is important that the language situation which the child inherits, as he inherits his family or his country, shall be correct. The child comes into possession of a good, bad, or indifferent speech situation just as he comes into the social status and religious and political convictions of his family. If the members of his family use clearly enunciated and varied words, rich in number and content, spoken in modulated tones, the child will promptly acquire elaborate tools of spoken and silent thinking. He will acquire correct pronunciation by unconscious imitation and will learn to enrich his use of words by associating with them fine shades of meaning.

Improper Language.—The child who is able to satisfy his inherent craving for free exercise of his organs of speech and thought and who has a satisfying variety of experience, will not as a rule be attracted (permanently at least) by the language of the ignorant and uncultivated. He will not need expletives and slang to pad out and complete his limited and inadequate assortment of symbols of expression.

It seems reasonable to suppose that expletives are relics of the one-word sentence of the child. The individual under the stress of necessity for being effective in speech without having an adequate assortment of words, "packs a punch," so to speak, into unusual or tabooed words. At certain stages of development children feel this need ontogenetically just as persons of arrested social and mental development exhibit a corresponding phylogenetic tendency.

A three-year-old who was being carefully reared in a cultured family and was not supposed ever to have heard an improper word crawled under a bed in an attic after his ball. His astonished mother heard him say expressively several times, Gosh! Gosh! When he crawled out his mother said "What did you say, Frankie?" "Gosh!" answered the unafraid child. "Why did you say that?" "Gosh, Mamma, it's dusty under there!" Being taken by surprise, and not knowing what to do, she wisely did nothing. While the rather bewildered young parents were anxiously consulting, Frankie, not having the word impressed upon his mind by dramatization, promptly forgot it after a short period of experimentation, and was never given to the use of crude or vulgar language.

The author was acquainted with two other children who were reared to the age of four and a half probably without ever having heard emphatic expletives used. Their emotions were more primitive than their speech, however, and on one occasion when their nurse had required them to sit on chairs on opposite sides of a room for punishment, she was horrified to have them hurl at her with the virulence of the most concentrated profanity: "You old chair!" "You table!" "You clock you!" This same pair later acquired for their private, personal adjustments between themselves a prize epithet which seemed to carry measureless capacity for catharsis. This was "You-old-maker-faces, you!"

The family adopted the policy of ignoring this phase, which soon faded out. When these children started to the public school they brought home during the very first days an assortment of "By George's," "Oh Heaven's," and worse. After experimenting with these for a few days or weeks, and creating no excitement and deriving no special satisfaction, these too were dropped. The young persons in question never afterward showed any tendency to adorn their speech superfluously.

Even very young children are highly sensitive to atmosphere and the customs of the country in which they find themselves. One mother anxiously inquired whether her boy and girl of twenty-five and forty months had been heard to use "bad language" at the nursery school. She was assured that the children were never out of hearing of an adult and that they had never been heard to say anything improper. She said the father was very profane and that the children when at home were beginning to talk like him and that her efforts to correct them only made them worse. Never before or afterward, however, did they use any such language at the school.

The child must be permitted to discover words and their uses just as he discovers and trains his body for use, and that is through exercise, experimentation, experience, correct pattern through family custom, and intercourse with friendly, cultured people. Under such circumstances the child experiences the same kind of creative joy in forming sentences that he does in drawing a picture or building a block house.

At the end of infancy, at two years or thereabouts, our child is entering the world of speech which is to open to him the limitless vistas of science, art, and creation itself.

Adaptive Behavior.—During later infancy the child integrates responsively with a wider environment. Speech and locomotion open doors of experience more rapidly than he can explore. No wonder he must be busy every waking moment; there is so much to know, to learn! Gesell in his normative summaries stipulates that every normal infant at twelve months of age shall unwrap a cube which has been folded in paper, that he shall imitate



FIG. 124.—Fourteen months and already going up in the world.

scribbling with pencil, and circular movements with spoon or rattle; put round block in form board or pegs in holes, and pull a string to secure an object tied to it. This means that the year-old child is bent on exploration. He creeps and climbs in order to explore. He may pull the cloth from the table, dishes and all, pull over furniture, break objects in his greed for knowledge. He loves to put a lid on a box or a cork in a bottle endlessly. His very useful fore finger, now separated from the thumb, is poked into everything. New tactile sensations delight him. He turns the pages of magazines and books, he manipulates paper, he runs or creeps after balls.

At fifteen months the child having a cube in each hand will manage to secure a third. He places one block upon another, places either end of round block in succession in form board, etc.

These tests simply measure increasing complexity of imitative and manipulative ability. He finds new relationships and begins to make combinations. At eighteen months he builds with three or more blocks; makes definite imitative strokes with pencil rather than random scribbling; places cube in cup; manages four or more cubes. At twenty-one months he places square in form board (children for some reason find the round block easier to manage than the square). He can tell a tower from a bridge in blocks or picture. He folds paper once imitatively just after some one has done it.

The infant can now run about freely. He can stoop over and pick up objects, squat down and rise unaided. He can turn the pages of a book deftly. He pulls rolling toys. He is constantly combining and exploring relationships. At two years the child can build a train from blocks, fold paper imitatively, put round and square blocks in form board when it is reversed from usual presentation, place cube in box.



FIG. 125.—Eighteen months old and bent on adventure.

Personal-social Behavior.—At twelve months our child recognizes a number of people, depending upon extent and kind of his social contacts. He recognizes and delights in pets. He has favorite toys. He remembers, sometimes for days.

If properly trained the child is conditioned to regular bowel movement and able to call attention to his needs by some vocal sign or grunt. At one year the child usually drinks from a cup with little help. He may try to feed himself with spoon; he manages bread or crackers very well. He responds to very simple commands—such as "No, no." He enjoys simple imitative games. He is sensitive to tone of voice and expression of face. He repeats performances when laughed at. He observes and grasps at reflection in mirror.

At fifteen months the child tries to help dress himself, he uses his spoon, he puts blocks back in box.

At eighteen months he feeds himself with good control; turns pages of book; enjoys pictures, recognizes familiar faces in photographs; enjoys stories, rhymes, and music; he is able to remember not to do forbidden things. The child at one and a half years delights in another infant or an animal, although he is apt to maul a cat or dog about rather roughly.

At twenty-one months the child asks for things at the table and to go to the toilet; he pulls at dress in order to attract attention; tries to turn door knob. He may play imaginatively, for example eating make-believe food from empty dish.

At twenty-four months he is taking a determined interest in dressing and undressing and can do more or less of it by himself. He feeds himself expertly. His toilet habits are thoroughly established; he exercises much caution in avoiding danger. He tells experiences; recognizes and explains pictures. He recognizes and names several colors; he knows his own name, he knows two numbers and has some concept of one or many. He tries to repeat familiar stories. He builds imaginatively and wants some one to see and appreciate what he has done. He pulls mother to come and see, and tries by word, gesture, and jargon to tell her about it. He is increasingly imitative. He is active, affectionate, busy, and shows very definite individuality.

With all these statements of norms and likeness, no two children (except identical twins in the same environment) will ever be alike. At two years our child is through with babyhood; he is assuming responsibility for his own care, safety, and conduct. His adults should salute him and respect him!

Training in Later Infancy.—The principle of training during this period is similar to that of early infancy—to foster increasing adaptation to a stable and regularized environment. The child must continue to learn to accommodate himself to necessary conditions: food and sleep must be wisely regulated to meet changing needs of the child. Changes in schedule may need to be made gradually or abruptly according to the child's development. He may suddenly become unable to go to sleep at his regular nap time. This may, of course, mean temporary excitement or too long a morning sleep. It may mean a lessened need for sleep. In the nursery schools this particular emergency is met by having all children lie down at some midday interval.

This is made a pleasant occasion by soft music, very quiet story telling in a low monotonous voice, etc. All the children rest, and most of them drop asleep sooner or later for part or all of the period.



FIG. 126.—Two years old and not afraid.

The tactful mother will not make an issue of the nap and arouse resistance. Her object is not the satisfaction of enforcing obedience; it is to rest her child. A sulky, negativistic child is not likely to relax or to derive benefit from enforced inactivity. It

is her job to make the nap time a happy, matter-of-course time and to recognize when the day comes for changing from a two-nap to a one-nap schedule and finally to recognize when a quiet happy rest period must replace sleep. Most two-year-olds require one fairly long nap in the middle of the day. This means four meals per day, as the child must have his dinner early, and will require midafternoon food to carry him to his evening mealtime (chap. XIX).

Feeding discipline has been discussed in chap. XVIII and also in connection with early infancy. The best assurance of food conformity is a healthy appetite and a balanced and varied diet, with regular feeding intervals.

Quiet, unemotional inflexibility should prevail in regard to meals and sleep in essential details, permitting the child the satisfaction of choice wherever the details involved are nonessential.

Safety. *Safety from Falling.*—Training for safety is important during this period when language as a means of accurate communication is limited, and the child's clumsy, uncertain locomotion presents increased hazard. From the time the child can sit alone until he is able to climb out of his pen, the play pen is an important item of equipment. The child is safe and has more freedom in his pen than when he is confined to crib or bed. He should be placed in his pen whenever the mother is too busy to give him her personal attention. It is a good plan to have a small indoor pen with floor raised a few inches to lift the child above dust and drafts, and a larger fence-like enclosure of slats or poultry netting which may be moved about the yard according to shade, wind, etc. (see Fig. 67).

When the child is at large, so to speak, during his creeping months he does require constant watching. This is a most important period in training for safety and caution. Children should not be conditioned by fear so much as helped to learn how to take care of themselves. Instead of trying to make a child afraid to climb the stairs the mother should take time to help him learn how to come down as well as go up (see Figs. 68, 124, 126). If a gate can be put on the stairs three or four steps from the bottom, during this period of exploration on the part of the child, he will thoroughly enjoy going up and down the lower steps and will learn for himself how to negotiate steps

safely and independently. In nursery schools a set of three or four steps forms an item of equipment of value in achieving motor skill.

Small platforms and packing boxes of various sizes help children to learn where the edges of things are, and they soon learn not to walk off the edges of steps, sidewalks, and platforms.

The child may be helped, by making every experience a complete experience, to recognize hazards and overcome them. The first time the toddler stumbles over the doorsill, instead of picking him up with pity and caresses and saying "Nasty old



FIG. 127.—Children climbing.

floor to hurt my baby" let the mother help him up, show him the sill and how his toe caught on it, then lead him over it again, showing him how to lift his foot a little higher at the sill.

Unnecessary hazards should be eliminated in every home. Stair steps should not end flush with a door, for instance, either going to the basement or coming down from the second story. Even an adult is apt to open a door and step inside without looking at his feet. There should always be space to take a couple of steps before starting down the stairs. All stairs should be provided with at least one handrailing.

The railings about second-story verandas and porches should be high and secure. If such a space is desirable as a play place

it may be reinforced with poultry netting while the child is small.

Window screens should be securely fastened, especially those of the upper story, and the netting should be strong enough and fastened securely enough to bear the weight of a child if he accidentally falls against it.

Fire Hazards.—Fireplaces should be protected by heavy fire screens. Bonfires should be carefully watched. Matches may be fascinating objects to the two-year-old. One mother taught her runabout child to bring every match to her and let her pinch off the head. That belonged to her—it was "Mamma's"—the stick "belonged to baby." Eternal vigilance in keeping matches systematically out of sight and reach, or, better still, the use of safety matches only, is the only safe method for this period of active exploration and experimentation.

Toddlers are frequently "possessed" to turn gas jets; merely saying "No-no" and spatting hands may only lead the child to explore when mother is not looking. The only safe method is effectively and completely to allay the child's curiosity. One mother, discovering her child turning the gas jets on the kitchen range, said, "Those are mother's. Baby must not touch mother's handles. Baby must touch here"—pointing to the broiler-door handle. "Now what is mother's place to touch?" The child pointed to the jets. "Now what is baby's place to touch?" The baby pointed to her handle. "Baby will never touch mother's place?" The baby shook her head. The child never again molested the jets. Each mother must try in her own way to condition her own child to particular situations without undesirably repressing the desire of the child to learn.[1]

Water Hazards.—Lily pools, fish ponds, stock tanks, etc., should be well guarded. Poultry netting may be used about pools. Watering troughs and tanks on farms should be securely fenced, if there are toddling children about, although children promptly learn where danger lies and it is the visiting child who is unaccustomed to seeing bodies of water, that falls into them. However, any small child may accidentally fall or be pushed into deep water.

[1] FENTON, *op. cit.*, pp. 279–281.

Electricity Hazards.—The chief hazard is in touching exposed contacts in sockets or attachments with wet fingers. Open floor and wall sockets should have plugs screwed into them at all times. All electric attachments in bathrooms should be particularly well guarded, as even adults may electrocute themselves in merely turning a switch while standing in water or using wet hands.

In every family there should be one expression which will arrest motion instantly, and *this should be used only in emergency.* "*Stop*" is a forceful and arresting word, but any word loses its force with too much repetition.

Emotional Training.—As was stated in chap. XXIX, the supreme emotion of childhood is the joy of accomplishment. Every waking moment the child is trying with desperate intensity to accomplish something. He is happy as long as he is free to carry on his quest for truth. When he meets situations he cannot master and is baffled and thwarted he becomes afraid (withdrawal) or angry (aggressiveness). He rejoices in conquering difficulties. The child at every age works intensively to accomplish his purpose, disregarding hurts and fatigue to a surprising degree. Miss Shinn describes the effort of her niece at three months of age to raise herself to a sitting position (see page 493). A runabout child intent upon a goal will forget hunger, thirst, the need to defecate and urinate, will be insensible to cold and wet, until he succeeds in completing his building of a tower of blocks or making a train of cars out of a pile of bricks he has chanced to find in the yard.

It is to be hoped that the parents of our two-year-old will have encouraged their child to achieve, that they will have permitted him to overcome difficulties to the extreme limit of his capacity, but that they will have protected him as far as possible from experiences beyond his developmental level of comprehension, which necessarily create the undesirable and destructive emotions of fear or anger.

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CHAPTER XXXI

THE TWO-YEAR-OLD

There was a child went forth every day,
And the first object he looked upon, and received
With wonder, pity, love or dread,
That object he became.
And that object became a part of him for the day
For a certain part of the day, or for many days,
Or stretching cycles of years.

WALT WHITMAN.[1]

Command of Body.—The second birthday has seen our child firmly balanced upon his feet, able to get about freely and swiftly and to explore his environment in its height, breadth, and depth with a fair degree of safety and efficiency. If he has had proper freedom and encouragement he is now in reasonable command of his body; he feeds himself with very little assistance; goes to the toilet when necessary, requiring help only with difficult fastenings, and washes his own hands; if his clothing is sufficiently simple he can remove his clothing and assist in putting it on. He is intensely interested in doing for himself. He resents unneeded assistance; he would far rather get a drink for himself than have it handed to him. He actually enjoys wiping up his own spills. The wise parent will further this independence to the fullest extent, recognizing that his maturational urge is indicating that now is the natural time for setting up an individual and independent personality.

His horizon is expanding day by day as he sees farther into the world about him. He is also discovering a wealth of detail in familiar objects. To the one-year-old the cat was a soft moving object which could be mauled about agreeably and which said "meow." Now the cat is discovered to have fur, eyes, tail, ears, and claws, each of specific interest. Spinach is not only something more or less satisfying to put into the mouth, it is something

[1] "There Was a Child Went Forth," from *Leaves of Grass*, reprinted by permission from Doubleday, Doran & Co., Inc., publishers.

which grows in the garden (we hope he has a garden), which is cut, washed in alluring manner through many waters, cooked, changes its color, has salt and butter added—all prior to, and interestingly related to, the eating of spinach. He is interested in the entire procedure and wants to help with it all from garden (or better still, from garden-seed) to table.

If his physical regimen in food, sunshine, and sleep has been correct up to this time, his body will, in a sense, run itself for the next three years (or indeed, for the rest of his life!). He should now be well stabilized in his health habits and in physiological growth.



FIG. 128.—We hope he has a garden (twenty-seven months).

Mental Food.—His dominating need from this time on is intellectual companionship. He now needs a balanced mental diet in exactly the same sense that he needs balanced food at table. This mental diet should be adapted to the maturation of his brain precisely as his food must be adapted to the maturation of his digestive system and the metabolic needs of his body.

As his physical habits have been established, so now his mental habits, good or bad, will be established. His personality is taking on final configuration. It is indeed a critical period. Parents should realize this and try to prepare themselves to meet the situation just as modern parents are training themselves in adequate management of the factors of physical health. The ascendancy of mental demands over physical is not an abrupt process, as might be inferred from these rather too definite statements, but rather a gradual process which might be expressed in a normal frequency curve extending roughly from eighteen to thirty months of age with its median at about two years. After the peak, whenever this appears, the child gradually becomes able to think for himself in a manner comparable to his assuming charge of his physical body. This is wholly

imaginary, of course, since there are as yet no tabulatable data of measurable factors to correspond to the relatively definite growth and nutrition curves. Probably most observers of behavior development, however, will accept this statement as being broadly true.[1]

Much of the present scientific information in regard to food and metabolism has been obtained from experimentations with animals. The chemistry of living protoplasm in all living

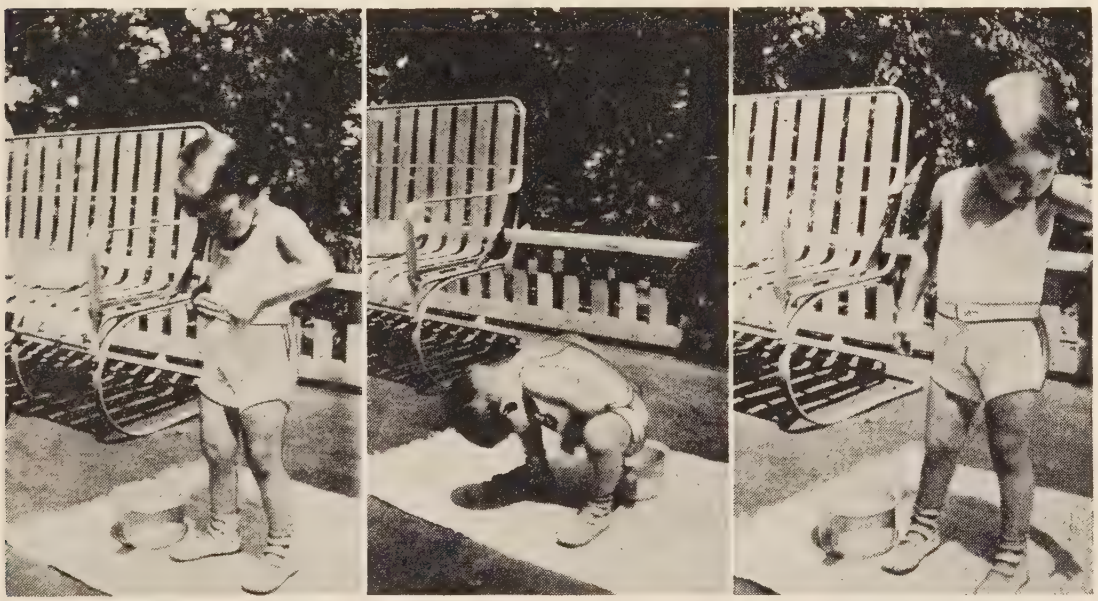


FIG. 129.—Thirty-months old and quite independent. Note the one-button self-help garment. (*Courtesy of the Ernshaw Knitting Company.*)

organisms appears to be one fundamental process. If this is accepted and if we accept, or assume, that the principles set forth in the present text as to the protoplasmic basis of behavior are true, it would seem reasonable to expect study of the behavior of lower animals to throw light upon human behavior. Striking parallels are being discovered between the intellectual responses of the higher apes and those of the child at approximately similar levels of cortical integration. Mention has been made of the so-called "simian stage" of intellectual development in infants.[2]

[1] FENTON, JESSIE CHASE, *Psychology of Babyhood*, pp. 312–314. Houghton Mifflin Company, 1925.

[2] There are stages of child-development in which intelligent performances gradually become possible which, according to Köhler's investigation, are

The fact that organized protoplasm tends to react in a patterned manner to organized or patterned stimuli has been demonstrated by Gestalt psychologists upon rodents, fowls, dogs, apes, and many forms of animal life. It appears that science may be upon the way to the same careful identification of the factors of learning and behavior that we have seen in the identification of vitamins, minerals, and proteins, and the responses of the human body to them.

As we proceed with our study of the behavior of our two-year-old, let us keep the accepted principles of *maturation* and *configuration* clearly in mind and see if these furnish logical interpretation of the conduct of the child, and if they guide us in our effort wisely to help him in the establishment of correct self-control.

Our first query, in line with the above suggested procedure, will naturally be: how far has maturation proceeded? What sort of response is his organism now prepared to give? It is as illogical to expect him to grasp social concepts (such as polite conventions, vicariousness, and morality), which are beyond the range of his ability and experience, as it would be to expect him to lift weights or perform feats beyond his physical strength.[1]

Orientation in Space.—What, then, is the mind of our child structurally ready to do, as he enters the third year of his life? First of all we may say he is equipped to explore in wider arcs the *space* surrounding him. According to the freedom with which he is permitted (*he should be assisted*) to negotiate distances, he becomes able to estimate distance and accommodate to the apparent size of remote objects and to form judgments which will determine and train muscular coordination. The child must learn through experience not to reach for the moon, and discover that the child a block away is not a doll. He must learn through experience that he cannot go across the street

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also typical of chimpanzees" (KOFFKA, *The Growth of the Mind*, p. 43, Harcourt, Brace & Company, 1927).

The term "Simian age" is used by Dr. Karl Bühler to apply to the period during which the child solves test situations much as did Köhler's apes (*Mental Development of the Child*, Harcourt, Brace & Company, 1930).

[1] WAGONER, LOVISA C., *The Development of Learning in Young Children.* chap. V, Maturation, McGraw-Hill Book Company, Inc., 1933.

as he goes into the next room. The child who is confined within narrow spaces and who is not permitted to gratify his natural exploratory urge will be retarded in acquiring complete and competent space configurations. That the child is now structurally and mentally ready for this experience is shown by his ability to walk, climb, and run, and by his insatiable urge to use this ability. The child will usually pass through a peak of exploratory zeal during which he is "on the go" incessantly. He does not sit down to detailed projects, he is interested in what is just farther on. He is blocking out or surveying the configuration of his world. *He is orienting himself.* Presently he will return to the items which he discovers and examine them in detail, but first he wants to experience the whole of it. The limit of the "whole" constantly expands. At first his bed and his play pen limit his spatial configurations. Then he discovers the spaces of his room, the adjacent room, the house, the yard, the block, the town.

Parents sometimes fear that the child who is passing through this period is showing "lack of concentration," that he may remain "flighty." The wise parent will recognize the futility and undesirability of trying, during this period, to force such a child to "stick to one thing."

Running away at this age is prompted more by the urge to explore space than because of the desire for companionship, which later becomes the dominant motive for breaking bounds.

The management of this orientation period presents one of the most difficult situations the parent has to meet. The child cannot be permitted to roam at large. He must learn to conform to the restrictions dictated by safety and convenience. How are we to accomplish this and still satisfy his normal, necessary, and laudable desire to learn about space and distance? Here is where the companionship of older children is valuable, as provided in the set-up of the old-time family. If a trustworthy older child can be placed in charge of the exploratory-minded toddler, with instructions to permit him to go, so far as possible, where he desires, and to tell him and show him everything he can understand and wants to know, this may be far better for the child than the companionship of a less agile and less patient adult. Lacking the service of an older child, the parents must

make whatever shift is possible to give the child this vitally educational experience.

The child must be made to understand that children of his age do *not* go anywhere alone and that he is to ask for escort. When he does indicate his desire to go upstairs or into the yard or into the street he should be rewarded by understanding attention and at least some degree of satisfaction of his desire. If it is impossible to gratify the request at the moment this should be explained to him in words which convey meaning to him, and the adult should show as much courtesy and respect as he would to the expressed desire of another adult. The abrupt and even discourteous refusal and rebuff with which the adult sometimes meets the insistent and often inconvenient demand of the child at this critical period plays a large part in establishing negativism and conflict. A diversion of interest is, of course, the easiest way of meeting the situation.

Modern young mothers who are trying to understand and meet the developmental levels in their children's behavior report that even the two-year-old will go to surprising lengths in coöperation when the mother makes him understand that she does not disapprove of what he wants to do, and that though she cannot help him or accompany him just then she will at another time. To be sure, she must see to it that there *is* another time, and that the child has reasonable and abundant opportunity to get the particular urge "out of his system" through adequate and appropriate experience. If she is not wise enough to do this she has no one but herself to blame should he seize illegitimate opportunities for obtaining the experience his growing mind so eagerly craves and have an orgy of "running away." This statement holds true for all the developmental urges as well as for the particular urge to explore space.

The drive to explore is the tool whereby the child orients himself in the big world. It is essential to progressive learning that he should learn early to use this tool wisely and thoroughly. It is a mistake to restrict his experience to occasional and haphazard calls, shopping trips, and excursions planned only to meet the convenience of the mother, during which he is constantly restrained from investigating and handling and making the intimate and satisfactory acquaintance of what he does see. The

result of such tactics is to pile up fragmentary and distorted and incomplete experience for the child. Too often he only becomes fatigued and bewildered and "difficult." He may even have his attempts to ask questions or acquire information ignored or rebuffed by his preoccupied mother. A little thought will show the effect of such experience as a factor in establishing negative attitudes and repressions in the child.

The inclination to explore space never dies, of course, but the peak of restless ascendancy which we are here discussing may occur at any time and, unfortunately, often tends to anticipate the capacity for cooperative adjustment which should assume ascendancy during the ensuing year. A burst of interest occurs normally whenever the child's horizon is widened by circumstances such as the onset of spring with the opening of doors and the extended activities of the entire household, a family excursion or picnic, a long trip down town, etc. The speed and sureness of his locomotion also, of course, largely determine the extent and time of the child's exploration.

The child who has been confined rather rigidly at home is apt to have an explosion of exploratory urge when he first starts to school. He has discovered a new and wondrous world of community life: alleys, cats, dogs, traffic, and active groups of other children (it is even occurring to educators that the child's keen and acquisitive desire "to know" is a developmental phenomenon, and that his own selections of subject matter might well be taken into consideration in constructing curricula). This is simply one way of saying that the child can learn only through his sensory experiences. Telling him things, at this age, is futile unless he can see, taste, touch, handle, or "experience" the thing mentioned. Hence environment in large measure determines trends of interest and learning.

The writer had an experience illustrating the instinct for orientation when a mother with a two-year-old child came to live in her home. At once the child started to explore the house. Her mother was much embarrassed and tried to restrain her. The writer insisted on accompanying Lucy on a tour of inspection, permitting her to investigate every room and every closet and handle everything about which she was curious, and explaining to her where she was to live with her mother and father, and

where the other family were to live, and that they would be glad to have her come to see them *any time they were there.* The result was that during an entire year of joint occupancy of the house the child never invaded the privacy of the second family or committed any depredation whatever (with the exception of one glorious "make-up" at a toilet table!).

The instinct for orientation is primitive and doubtless protective. On another occasion the family dog, a terrior, was taken to spend a summer in the boarding school attended by the young daughters of the family. When released in his new surroundings the terrier promptly disappeared. After a time he returned breathless and satisfied and was reported to have explored on the run every nook and cranny of the large building. After seeing for himself what sort of place he was in, he promptly settled down to reasonable acceptance of the spatial restrictions imposed upon him.

The Nature of Things.—As our child goes about his little world he is interested not only in the extent of it but in the characteristics of it as conveyed to him by his senses. His senses are the servants of his mind. His feet carry him to the rosebush, but his eyes convey to him an image of size and form and color. He eventually becomes aware of, and able to express in words, the fact that the leaves are green and the flowers red. If permitted to handle the parts to his satisfaction he will discover that the stem is hard, the thorns sharp, the leaves stiff and the blossom soft and fragile. He may discover that a branch may be broken from the bush and that he can wave this about, or strike the ground with it. During this activity he may notice the fragrant odor. If he puts some of the leaves or flowers in his mouth he will get a distinct impression of taste. As he waves the branch he receives tactile sensations of mass and size and weight. If an understanding companion is near who says "roses," "leaves," "stem," "thorn" to him, he associates an auditory image with his experience and at that or a later time will experiment in reproducing the sounds which are now conditioned or integrated with the other items of the configuration.

If intelligently managed the child has had a "lesson," a "complete experience." This will be effective, in other words the child will *learn,* only if maturation, experience, and interest integrate

to form an organic "whole." If the child were intent on an orientation excursion to the garage at the back of the lot, the time would not be propitious to pause at the rosebush for a "lesson."

At a later time the child may enlarge his configuration of the rosebush as his experience takes in a wider radius, by noticing that it is attached to the ground and does not move about as does the dog or cat. He may observe that the rosebush sways in the wind while the house and the electric light pole do not. He will notice the relative size of the bush, the elm tree, and the nasturtiums. These are concepts which will probably come later, after he has felt, smelled, and visualized the physical qualities of the rosebush. The process of comparison or reasoning will be evoked. Before the child can compare he must have a sufficient supply of facts, experiences, or small configurations. Later, large configurations arise out of a larger vagueness as he sees farther and attains further maturation of his behaving mechanism. The small configurations must be accurate and complete, or his enlarged pattern or configuration will be imperfect or incorrect. The child who has experienced only branches of rosebushes brought from the florist will have an inadequate and distorted concept of a growing bush.

The child who is not permitted to handle the vase upon the piano under guidance, but who pats the picture of a vase in the book and turns the pages without disaster, must not be blamed if he later breaks a family treasure.

Therefore, as our child moves about, eagerly orienting himself in a large new world, receiving patterns of imagery and relationship within the plastic cortex of his brain, he tries all his senses upon the objects which he meets. He is becoming cautious about tasting strange substances, but he handles, lifts, feels everything, and if he possibly can he moves and carries and manipulates new objects. He wants to know *everything* which his senses in their state of development and training will tell him. He listens with interest to all statements or explanations which are couched in language he can understand.

The importance, during this period, of understanding companionship and of conversation which *follows the interest of the child* cannot be overestimated. The point must not be lost,

however, that the elder must follow and not dictate or even suggest or stimulate effort beyond the spontaneous interest of the moment. The child should be told *all* he wants to know, and he should have all his present curiosity satisfied as to physical properties, uses, etc. To go beyond this is to force his mind beyond its maturity. When he has mentally organized and assimilated this experience he will want to place it in a larger pattern. He still needs the elder right at hand to give him just the help he requires (and no more) when the larger relationship bursts upon him; when he wants to know *why* the rosebush stands still, or *why* the petals fall and the leaves do not, or, still later, *why* trees and flowers stand still while dogs run and birds fly.

The child must be given full opportunity to *organize his own experiences.* The adult cannot do this for him. This has been the fault (and still is in many cases) of educational method. We tell a child that a ball is round or that two and two make four, and when he repeats this parrot-like we are apt to think that he has learned a fact. Until he has knowingly experienced roundness or twoness and fourness we have not only wasted our own time but we may have actually retarded and bewildered the child.

Expression.—The increasing contact of the child with environment creates an inner urge for expression, an innate necessity "to do something about it." His incredible brain wants to do something tangible and material with the tangible and material part of his environment. He also wants to communicate with other conscious, thinking, living things. He therefore begins to create and to converse.

The Language and Thought of Early Childhood.—Jean Piaget classifies the language of childhood as first *egocentric* and later *socialized.* Egocentric language he further classifies as (1) repetition, (2) monologue, and (3) collective monologue. Socialized speech, which does not occur, according to his observation, until later childhood, is classified as (1) adapted information, (2) criticism, (3) commands, requests, and threats, (4) questions, and (5) answers.[1]

The child during his early years is intensely egocentric. The infant is at first only dimly aware even of his own body. In

[1] PIAGET, JEAN, *The Language and Thought of the Child,* chap. I. The Function of Language, Harcourt, Brace & Company, 1926.

later infancy he becomes vividly aware of himself, takes charge of himself in a measure; during early childhood, as we shall see, he becomes increasingly aware of others.

Piaget made his observations on the language of children in the Maison des Petits (Geneva), a school for young children somewhat resembling our nursery school, and his conclusions are based on an analysis of the utterances of the children in this school. He says that with the exception of questions and answers, which he puts in a separate category, "the child's language . . . constitutes . . . a complete whole in which [his] intelligence is represented at every stage of its development."[1]

Accordingly, most of the child's conversation during his egocentric period is not addressed to anyone in particular. We have seen that endless repetition of syllables and sounds characterizes the child's first vocal efforts. He continues this in learning names as his twelve months' vocabulary of between 2 and 10 words increases to an indefinite number at twenty-four months, at which time he is beginning to combine two or more words into very simple statements. As he learns a new word he may repeat it over and over in much the same manner that he repeats a new motor activity.[2]

The child is incapable of keeping his thoughts to himself; he utters, or tries to utter, everything which comes into his mind. He prattles as he works. "He has no verbal continence." He keeps up a string of running statements as to what he is doing, couched according to his vocabulary, first in jargon, then in words, now in sentences of two or more words. "Speech, before it can be used to socialize thought, serves to accompany and reinforce individual activity."[3]

He is not unaware of his companions, but he is unable to express himself from their point of view. He shows this in what Piaget calls *collective monologue,* in which he speaks for the purpose of being heard, but does not speak directly to another child.

In a word, the child hardly ever even asks himself whether he has been understood. For him, that goes without saying, for he does not

[1] *Ibid.*, chap. I, p. 35.

[2] Smith, Madorah Elizabeth, An Investigation of the Development of the Sentence and the Extent of Vocabulary in Young Children, *Iowa Studies in Child Welfare*, vol. 3, No. 5, University of Iowa Press, 1926.

[3] Piaget, *op. cit.*, pp. 38–39.

think about others when he talks. He utters a "collective monologue." His language only begins to resemble that of adults when he is directly interested in making himself understood; when he gives orders or asks questions. To put it quite simply, we may say that the adult thinks socially, even when he is alone, and that the child under seven thinks egocentrically, even in the society of others.[1]

The transitional character of the child's thought at this period as expressed in speech is further described by Piaget.

The child is neither individualized, since he cannot keep a single thought secret, and since everything done by one member of the group is repeated through a sort of imitative repercussion by almost every other member, nor is he socialized, since this imitation is not accompanied by what may properly be called an interchange of thought.[2]

Questions.—The child's first question is "what is that?" This is his vehicle for accumulating names of things. This comes very early, between one and two years in many children. When the child has acquired a sufficient store of name words and action words together with a few prepositions, descriptive words, and pronouns, he begins to use words as a tool for the acquisition of knowledge to supplement the evidence of his senses. Up to this time he could not ask "Is the stove hot?" he could only touch it to find out. He evidently does not think much beyond the evidence of his senses. With the acquisition of the new tool of adequate language (which marks a new maturation level) he becomes able to establish endless configurations of relationship,

[1] *Ibid.*, p. 40.

[2] *Ibid.*, p. 41.

"The age at which collective monologue marks a stage of development is between three and four to five. The higher forms of conversation do not on the average appear before the age of five, at any rate not between children of the same age and of different families."

The following is an example of children busy with a common interest (drawing the story of the three bears) talking about the group interest but in monologue:

"Lev (5;11): It begins with Goldylocks. I'm writing the story of the three bears. The daddy bear is dead. Only the daddy was too ill.—Gen (5;11): I used to live at Salève. I lived in a little house and you had to take the funicular railway to go and buy things.—Geo (6;0): I can't do the bear.—Li (6;10): That's not Goldylocks.—Lev: I haven't got curls" (Piaget, *op. cit.*, p. 58).

a process which is to continue unceasingly as long as the individual continues to think and reason.

When he begins to ask questions, as with the monologue, the child cannot keep still. His queries must be voiced even though he knows or can easily ascertain the answer. He is still thinking out loud. Later he becomes able to suppress much of his questioning aloud and thinks things out, or finds out, or looks up the answer for himself, or asks only certain appropriate persons to tell him what he wants to know. This is in line with his increasing ability to keep his thoughts about his activities to himself. He becomes able to think silently.

The "why age" begins between two and three, usually well toward the third birthday, depending somewhat upon language development and upon the richness of experience and the degree of freedom and spontaneity accorded to the child. The peak of the vocal questioning period may appear between four and five, and it tends to fade by seven as the child matures in his thinking to himself. Piaget classifies "whys" as: the "why's" of *casual explanation*—"why haven't they (little goats) got any milk?" and the "why's" of *motivation*—"why are you going away?" and the "why's" of *logical justification*,—"why do people say strayed; does it mean lost?" These obviously represent somewhat ascending degrees of complexity in thinking.

The vocabulary growth of children from two to five has been sketched in the previous chapter. The child of three with a vocabulary of 1,000 words can ask a great many questions. Indeed, his ability to ask questions doubtless has a good deal to do with his rapid increase in vocabulary between two and three.

Until the "why age," the child's thinking is purely egocentric. Everything relates to himself. He cannot conceive of facts as existing apart from his relation to them. He would cheerfully eat the last bite while his mother starves because he has no concept of hunger apart from his own experience. With the rise of query he begins to be able to grasp relationships, and with incredible rapidity acquires concepts (configurations) of very complex situations.

The Rôle of the Adult.—As has been said, the need of the child during early childhood is intellectual companionship. To be sure, he will discover much for himself, and he should be per-

mitted to go as far as he can, since this is the basis of independence and is the only way to develop his abilities. At every turn, however, the toddler meets experiences he cannot understand without aid. He needs an understanding elder to answer *all* his questions; an elder who can, in as large a degree as possible, put himself in the child's place, conceive of the meagerness of the child's mental concepts, and explain to him in words which carry definite meanings to him, *just the thing he wants to know.* This elder must not only answer the child's every question; he should try patiently to understand the ideas which are shaping in the child's mind and protect him from making false associations and drawing wrong conclusions from fragmentary evidence, or rather, put him in the way of drawing correct conclusions for himself. This does not mean that the adult will overwhelm the child with facts. Rather, he will hand to the child *just the brick he is reaching for* with which to build his wall of knowledge. If the child has quiet and freedom and resources he will build firmly and symmetrically, guided by his unfolding organic urges. The adult must not meddle or confuse, he must protect and assist when needed and then only.

To change the figure of speech, the tentacles of the child's mind reach out for space and sustenance as the rootlets of a growing plant explore the soil. The quality of the soil must be correct (the balanced mental diet, correct environment) and the sensitive rootlets must not encounter too many stones or obstructions (repression, interference). Wise guidance is the gentle rain which renders the experiences soluble, while the sunlight of sympathetic, affectionate understanding vitalizes the whole process. To carry this figure to its logical conclusion it is necessary to mention the fact that the sturdiest plants learn to accommodate to wind and storm and chill and snow. This means that the child must be permitted to struggle for some of his experience, and only helped when his difficulties are clearly beyond his capacity to overcome. As expressed in a very practical terse precept in training: One should never do anything for a child *which he may reasonably do for himself*, and one should never tell a child anything *which he may, without too much difficulty or discouragement, discover for himself.* Guidance may often take the direction of leading the child to make discoveries and

of thus giving him the satisfaction of accomplishment and aiding him to build up independence and self-confidence.

In line with this precept is another to the effect that *the child should be encouraged in full and complete vocal expression.* If language is the tool of thought, fragmentary vocal expression may be taken as an index of slipshod and fragmentary thinking. It strengthens the child's thinking to state his meaning as fully as he is able. A very common error in child management is the custom of accepting detached words, grunts, and gestures in lieu of statements. The child will naturally spare himself unnecessary effort. If pointing to the sink and uttering a fretful sound will produce a drink of water he will not exert himself to say "I want a drink," or "please give me a drink."

While the matter of requiring complete expression from the child must not be overdone or allowed to become irksome or distasteful, the child should be encouraged to talk, and especially, he must be *given time* to put new words together and "say it all," even though the mother is in a hurry and knows what the child is trying to say, and even though it were much easier for her to interrupt by answering him or giving him what he wants than to wait until he has said completely what he is trying to say.

It seems reasonable to suppose that disjointed fragmentary language experience during the period of active language formation may affect in lasting manner the language habits of the child. Conversely, the acquisition of careful and precise habits of expression during this plastic, labile period can not help but affect favorably the permanent language equipment and promote habits of clear, precise thinking.

The rôle of the adult is to think with the child, in terms of the limitations of the immature child mind; to protect him from thwarting and baffling experiences which hamper and limit the satisfaction of his organic hunger for complete knowledge. To succeed in this the adult should know as well as science is able to tell him what to expect in the way of maturation plateaus or levels. At least he must be wise enough to follow Nature's lead, and especially not to enter into conflict with normal growth.

The Significance of Summaries for Early Childhood.—The normative summaries as outlined by Dr. Gesell are found in chap. XXXVII. It must be remembered that these norms are

minimum in that most normal children tend to exceed them. It should also be borne in mind that all such standards are relative. While all children tend to travel the same developmental road it is at varying rates of speed. One child may be eighteen months old chronologically and actually show some or all of the normative summaries for twenty-two months, while another child of eighteen months may only meet the normative standards for fifteen or sixteen months and still be a normal child.

Also, while all children tend to acquire special functional abilities, such as language and locomotion, according to certain developmental sequences, all children do not develop special abilities in equal degree or at equal speeds. The writer is acquainted with a rather large, heavy child of three years who speaks with unusual correctness, ease, and intelligence, who rates as four years old in speech, but whose motor coordinations are relatively poor and who is at least six months behind his chronological age in motor development. Another small, lively child who ran about on her first birthday like a child of eighteen months, going up and down stairs and darting about on the level with great speed, was only average in her acquisition of speech.

In the instance of any individual child too much importance should not be attached to any averages or tables of standards. These are useful more as pictures of normal sequences than as indexes of normality at any given moment of the child's life. For this reason it is desirable to test the child both by the age level and by the respective sequences as shown in the normative summary tables, page 638, which have been adapted from Dr. Gesell's data.

While these qualifying facts should be borne in mind it is helpful to have a somewhat organic picture of average development merely in order to understand the changing phenomena presented by the maturation of the child's body and brain.

Gesell says in *Infancy and Human Growth,*

> The obedience of mental growth to age probably is due to an intrinsic core of maturation, which is the matrix of the infant's behavior and the stabilizer of developmental trend and tempo. . . .
>
> Physical growth can be expressed in grams and meters. Mental growth, with our present method, must be recorded in behavior values. They are so complex, and at present so irreducible, that one can formu-

late them only in relative, orientational terms, in a hierarchic kind of seriation. Recognizing the crudity of the device, one speaks of stages of growth, or levels of maturity. Then, to give numerical status to these levels, they are normatively expressed in developmental ages; that is in months and years, mathematically precise units which psychology has borrowed from the ancient and exact science of astronomy.[1]

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[1] Gesell, Arnold, *Infancy and Human Growth*, chap. VII, pp. 150–151, The Macmillan Company, 1928.

CHAPTER XXXII

THE THREE-YEAR-OLD

Wouldst thou know how to teach the child? Observe him and he will show thee what to do.

FROEBEL.

The increasing maturity of the behaving mechanism of the child at three as compared with the child at two is shown in all his responses, which we shall discuss in terms of Gesell's classification.

Motor Development.—He is more certain in his movements, is less liable to fall, to stumble, or to drop and spill. He is more venturesome as to the difficulty of feats undertaken; he can climb higher and explore further. He can assist in setting the table with fair accuracy. He can hang up his own wraps (if the equipment permits) and put his clothing and toys in their accustomed places. He can place a set of blocks neatly in a box.

He dresses himself more completely and in less time than at two and can manage fastenings now which he could not manage at two. He is still interested in taking care of his own bodily needs, but these have ceased to have the absorbing interest of new activities. If successfully managed correct personal habits should now show some signs of becoming automatic. Not that the three-year-old can be depended upon to perform his own toilet and go to the bathroom with no supervision or assistance, but he should require much less attention now if his mother has carried out a consistent policy of encouraging full independence. Where the two-year-old usually holds the adult's hand when walking on the street, a year later he often enjoys walking alone like a grown-up. Since he gives less attention to the act of walking he can give more to where he is going. He can cross the street alone and watch for vehicles. He enjoys this new sense of efficiency and resents being led, helped up steps, etc.

The three-year-old should be reasonably skillful with tools. He loves to drive nails, saw boards, and dig holes. He can build

rather complicated block structures. He attempts new and difficult projects, and will work with desperate intensity upon them.

Language and Thought.—According to the Iowa study[1] of sentence formation, the three-year-old averages 3.3 words per

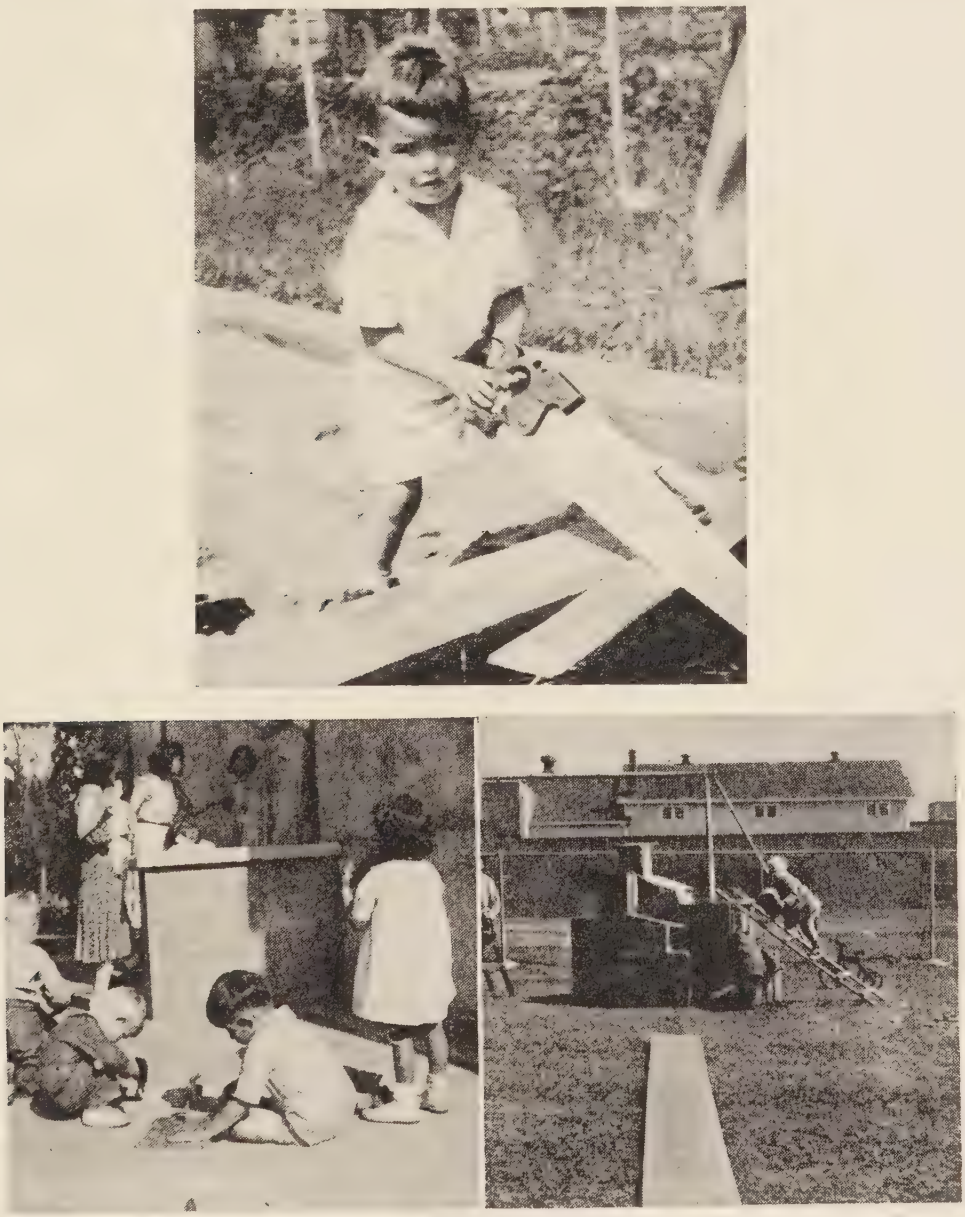


Fig. 130.—He loves to drive nails and saw boards and can build rather complicated block structures.

sentence as contrasted with 1.7 words per sentence at two years. In an average 1-hour conversation he uses 223 words as compared with 78 words at two years. This means that he can exchange ideas more fluently and ask many more, and more complex, questions. He begins to wonder about relationships as well as

[1] Smith, Madorah E., *op. cit.*

names and qualities of objects. He still thinks out loud, and he is still essentially egocentric. He carries on a running commentary about whatever he is doing.

He uses 68 per cent of complete sentences as compared with 37 per cent a year previously. He uses more verbs, pronouns, and qualifying words and relatively fewer nouns. He uses plurals and past tenses. The average three-year-old (according to the Iowa study) has a total vocabulary of 896 words as compared with 272 at two years.

He can repeat familiar stories and describe a recent experience. His memory span is lengthening.

He begins to discriminate colors; he has a vague sense of number, and distinguishes two, sometimes three or more.

AVERAGE ACCOMPLISHMENT IN WORDS OF 124 CHILDREN IN ONE-HOUR CONVERSATIONS[1]

Number of children	Age group		I. Q. (average)	Words	
				Total number	Number to the sentence
	Years	Months			
11	2	0	109	78	1.7
18	2	6	106	118	2.4
17	3	0	109	223	3.3
23	3	6	107	334	4.0
17	4	0	109	400	4.3
22	4	6	105	415	4.7
16	5	0		400	4.6

[1] From the Iowa study, *op. cit.*

Adaptive Behavior.—The three-year-old can draw a circle from copy, open doors, put on an apron before playing with paints, drag chairs to the table when the meal is ready, notice the habitual order of things in the home, and when his attention and interest happen to be fixed upon a situation will occasionally voluntarily cooperate in maintaining this order. Whereas the two-year-old will wrap a doll in a bit of cloth and be satisfied, the three-year-old may bring the doll and ask the adult to dress it or attempt to do it herself.

The three-year-old should know his own full name, the name of his street, and the name of his town. These names should be

impressed upon every child early as a factor of safety if he is lost or kidnaped.

Personal-social Behavior.—The three-year-old is increasingly fond of animals and small children. He notices their behavior and may want to feed and care for them. An infant should not be left within reach of a toddler, as he may try to lift and carry it, with disastrous results. He shows occasional interest in the comfort of others. He is vaguely and briefly distressed by the suggestion that the doll or the cat or his mother may be "hungry."

The three-year-old wants to help and participate in all familiar activities. He is pleased when his elders express approval of his efforts. One mother remarked, as she was making a pudding, "I believe I'll put in another egg." She left the room momentarily and when she returned the "other egg" reposed in the pudding, shell and all, while her three-year-old son beamed with gratification at having "helped mother."

In describing the two-year-old we said he was orienting himself in space and learning what his senses would tell him about things, and that he was busy discovering that he is a person and can operate himself. We might say that the three-year-old is orienting himself in social activity. He is interested in what is done *with* these hard, soft, round, light, heavy articles which he has discovered in his environment.

At two he was absorbed in discovering that the cat had fur, claws, teeth, and tail. He now discovers that the cat eats, drinks, and chases a ball when he throws it. He now wants to feed the cat and put her to sleep in his bed.

At two he was interested in feeding himself, at three he wants to help prepare the food and wash his own dishes. At two he discovered that peas were interesting round green objects which he could pour from cup to bowl endlessly, at three he wants to help shell and cook the peas and carry the dish to the table. He is in the midst of everything, always in the way. His "what?" has changed to "why?" and presently it will be the "why of the why?" and "how?"

This urge to orient in the life of the family or any living activity about him is as significant and critical as the drives to orient in space, and exercise his senses.

While the nursery school is making invaluable contributions to child development, one criticism has been made which would appear to be valid. The nursery school presents an artificial situation, and the child who goes through this phase of social orientation in the school rather than in the home may never feel so completely a part of the home life and be so familiar and efficient in home activities as does the child who participates in the actual daily activities, who is given a piece of dough on the other side of the bread board, who helps set the table and shell the peas, and follows his mother about in all her duties.[1]



FIG. 131.—Three years old and quite a member of the family.

This intimate life in the home also affords one important opportunity for development of the intellectual companionship between parent and child which we have said is the outstanding need of this entire developmental period. The mother who is prepared to recognize and enjoy the dramatic unfolding of her child's mind; who is willing to give him her thought and her time, has here an ideal setting in which to establish a rapport and a mutual confidence and understanding which anticipate and safeguard the relationships of the sometimes difficult after years. There is a temptation to shut the toddler away from the intrinsic activities of the home because he does interfere with the mother's accomplishment of her tasks. To do this, however, is to rob him of a rich natural educational experience. In homes where domestic help is employed the family is fortunate which

[1] STRANG, RUTH, *An Introduction to Child Study*, pp. 145–147, Helpful Activities, The Macmillan Company, 1930.

can command the services of patient, child-loving women who do not object to and even enjoy having a toddler follow them about and share their activities. Gardening, incidental repair work, or carpentering should be capitalized. On one occasion some painting was being done about a home. The small three-year-old was seized with an insatiable urge to "paint." Her nurse mixed some flour and water, gave her a brush, and engaged her to paint the basement wall. When she was completely satisfied the garden hose quickly removed the work of art. There had been no conflict and the child had learned something.



FIG. 132.—Paul at three and a half. "I think I'll stop trying to train him, and *observe* him for a while," writes his bewildered mother.

Management.—The line of training has been indicated in the discussion of personal-social development. It consists in meeting developmental phenomena in an intelligent, understanding, and helpful manner. The mental and physical development of the child and his increasing activity, however, bring problems of adjustment which are sometimes serious and difficult to meet. Among these are: (1) securing space and material for free activity; (2) helping the child to acquire independence of character without arousing negativisms and tantrums; (3) prevention of running away; (4) the establishment of good emotional reactions, especially the prevention of fears.

Space and Material for Activity.—With each year the child needs more space and greater variety of things to do. It taxes the resourcefulness of any household to keep a lively youngster busy. Helping mother (or the maid) as she goes about her work will consume more or less regular units of time. There remain long hours to be filled, and, if the child's developmental needs are to be met, wisely filled, with interesting things to do.

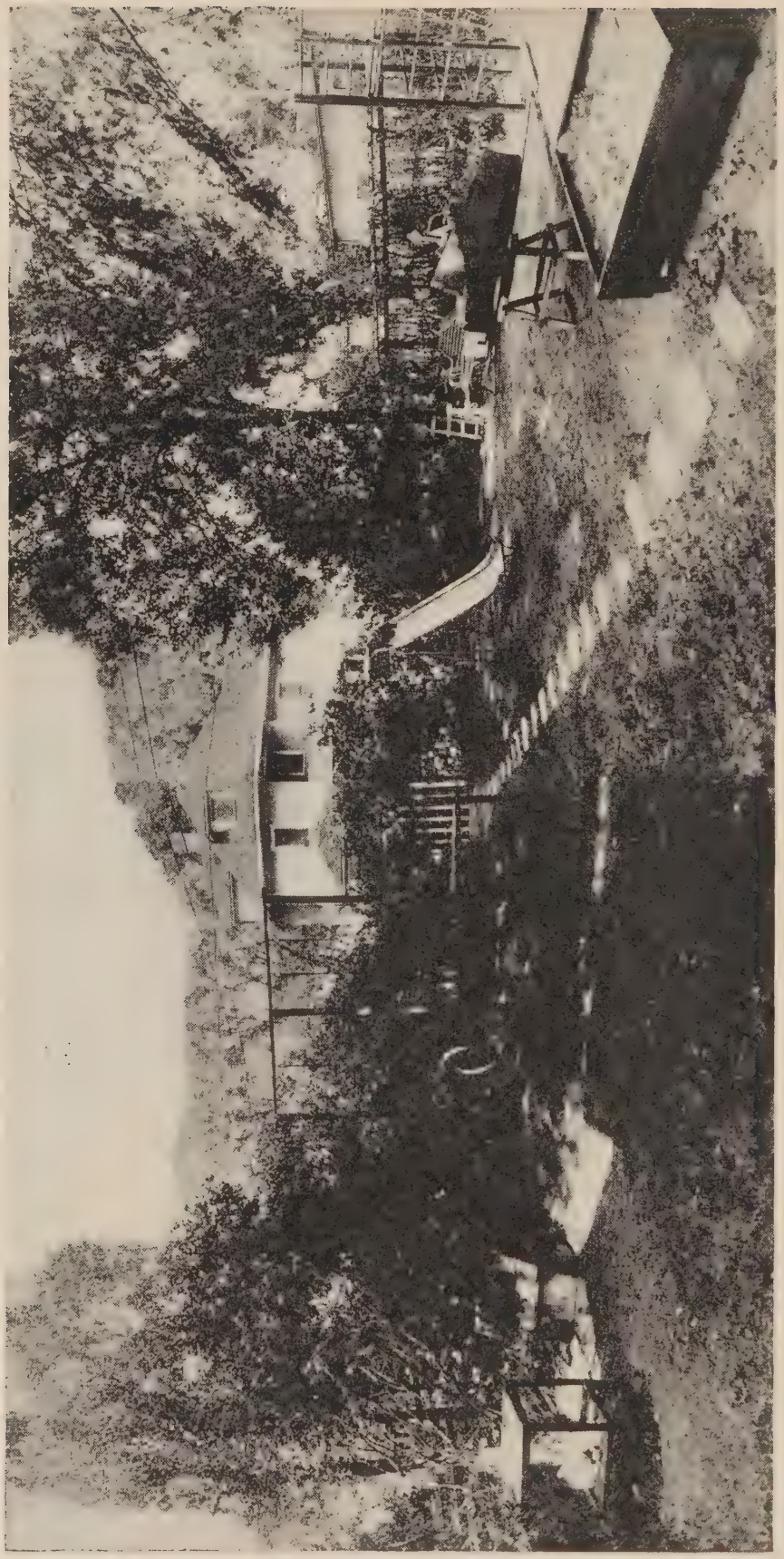


FIG. 133.—An attractive back-yard playground. Note the rabbit hutch and dog kennel. All equipment was made by the father.

Several modern young mothers of the writer's acquaintance are making a study of equipping their homes to supply these activity needs and still to preserve order and system in the



FIG. 134.—A small space will hold equipment for the essential big-muscle activities.

home. These homes are all five- to seven-room houses in small yards. The houses all happen to have cement-floored basements. The scheme these mothers have developed is as follows.



FIG. 135.—A spacious back-yard playground: the shallow wading pool is greatly enjoyed.

1. A playground space is set apart in the back yard, and equipment for climbing, sliding, digging, and throwing is installed,

at first very simply for the young child, who finds a sand box, a slide, a pile of boxes, and several kinds of steps and ladders sufficient to keep him interested and busy. In each of these instances the father is adding a piece of equipment from time to time to maintain interest and meet larger activity needs.

2. A corner in each basement has been set apart for "dirty activities." Here are found clay and easels and paints, tubs of water, also indoor gymnasium equipment for rainy days, such as swings and rings suspended from rafters, ladders along the



FIG. 136.—Any corner in a basement, which can be made clean and light, can be utilized for the more disorderly play activities and for rainy days.

wall, balancing boards, walking boards, etc. Particularly noisy things like whistles, bells, gongs, and drums are also kept here, as well as carpenter tools, boards, boxes, hammers, nails, and saws, and an indoor sand box.

3. In the family quarters some place—in several houses a small room—has been set aside; in one a wide passageway has been utilized, in another the child's own sleeping room. Here the quieter occupational material is arranged. Here are low shelves for books, games, and small objects, small wheeled apparatus, dolls, blocks, domestic equipment, etc. This arrangement really furnishes four varieties of employment: (1) following the mother around and using the family equipment and participating in the

family life; (2) free, big-muscle activity out of doors; (3) a generous and delightful variety of constructive activities in the



FIG. 137(*a*).—There should, if possible, be a corner for domestic play.



FIG. 137(*b*).—There should be adequate shelf room for small playthings.

basement which are not appropriate for well-kept living quarters; (4) clean, quiet occupational material which is not unsightly and not too difficult to keep in reasonable order.

This arrangement seems to be ideal as far as providing for the many needs of the child is concerned. Where the family must live in an apartment and the three several spaces are not available, the mother must be very resourceful and see how far she can go in meeting these different needs by screening and equipping a back porch and one corner of a living or sleeping room. The child must have outlet. He will seek for it through the grown-up possessions if he is not given possessions of his own which provide adequate outlet and exercise for his maturation



FIG. 137(*c*).—Blocks should be large enough to build with. These were sawed from 2 by 4 planks and dipped in dress dyes to make them decorative.

urges. It is far simpler to provide a child with these than to enter into constant conflict with him because he is driven to find his own.

The arrangement described makes it possible for the child "painlessly" to acquire correct concepts of order and ownership. In a household where there are no clearly established boundaries of ownership, and where there are not sufficient "places for things," including playthings, and hence things are not in their places, the child has no opportunity to develop orderly habits, or socialized and correct ideas as to sharing and ownership.

A confused environment prevents a child from forming clear configurations of thought and reasoning. He can be nothing

but confused and unpredictable in emotion and behavior and thinking.

Running Away.—Until the child has acquired reliable cooperative attitudes he must be safeguarded by supervision or by the enclosure of outdoor spaces. Poultry netting provides cheap and convenient means of enclosing either large or small play spaces. Such restrictions must not take the place of training in reliability. Every opportunity should be utilized for training and testing the child's cooperativeness and dependability. Sending him on small errands, gradually enlarging the distance and the size of assignments, with approving discussion of the excursion as a reward when he carries it out successfully, is one very educational way to go about this.

When the three-year-old does run away (as he usually will sooner or later) he may do so either because, being bored and seeing nothing interesting to do at home, he starts out to find something to do; because he remembers that Johnny has a set of fascinating tools; because he is lonely and feels the need of the companionship of the child down the street; or he may merely still have the spirit of venture and exploration which activated him when he first discovered a world of explorable space.

The effective management of the situation, in this as in every other situation, depends upon determining the reason for the escapade. The first thing to do is to talk quietly with the child, without creating a scene or dramatizing the event; the mother should get his point of view before giving him her own! Remedies should always fit diagnoses. If he has merely been bored the mother should consider herself the one to be punished and she should make a mental resolution to attend more strictly to her child's vocational needs. If the child craved companionship, this will be the mother's cue to arrange more opportunities for play with other children. If he wanted to see the world she should see that he does so under suitable escort. In the immediate situation the child should not derive satisfaction from it. He should be promptly returned to his home and a clear, simple, impressive but dispassionate explanation given him. This should not be too elaborate. "Mother *must always* know where you are, you *must always* ask mother when you want to go away. You cannot stay at Johnnie's when you go without asking

mother. You may play with Johnny only when you *ask mother first.*"

The same method should be followed no matter what the cause of the excursion. Prevention of similar conduct depends upon accuracy of diagnosis and skill on the part of the parents in preventing similar situations. If repeated the experience may be made definitely unsatisfactory by requiring the child to stay with the mother until it becomes irksome, explaining, without resentment or anger, that "*Mother must know where Billy is all the time.*" "Do you want to stay with mother all the time or can mother leave you in the play yard and know that you will stay there?"

The Emotions of the Three-year-old.—Volumes have been written, and at least one international conference (the Wittenberg Conference, Springfield, Ohio, 1927) held upon the subject of the nature of the emotions. For the purpose of this treatise we shall follow an exceedingly simple concept in keeping with the organismic theory adopted in this text. We have assumed that thinking is a function of protoplasmic reaction, although the nature of this reaction in terms of atoms and electrons is still unknown. Likewise unconsciousness, the storage of impressions in the unconscious, and the aspects of consciousness which we call sensation, feeling, and emotion, must be functions of protoplasmic reaction. These phenomena become complex as protoplasmic organization becomes complex, reaching their acme in the functioning of the incredibly complex organization of the adult human body and brain with its systems of neurones, glands, ganglia, fluids, and tissues.

As the human animal thinks as an organism so he feels as an organism. His emotional reactions are affected profoundly by the chemical states and activities of his physical organism. Conversely, the chemical reaction of his nerve cells, glands, and vital organs can be definitely altered by sensory impressions from a distance, such as sight and hearing, which do not impinge directly upon the physical structure (this is the reason why Child insists that social relationships *are biologically organic*). Emotional states may also be aroused by configurations arising in the associative mechanism of the brain, as when it suddenly occurs to us that a remark addressed to us a day or a week ago was intended to be insulting.

The earliest feelings and emotions of the child are simple, in keeping with the relative simplicity of his protoplasmic organization. He appears to have only a sense of comfort (well-being) and of discomfort (unfavorable conditions). He reacts with his whole body in resistance or withdrawal and has one undifferentiated cry.

The variety and intensity of his emotional reactions keep exact pace with the progress of the maturation (organization) of his body and brain. Discomfort expands to include all thwarting of inner drives to expression as well as active physical discomfort and pain. At two years his emotions are bound up with his drive to become independent of his previous caretakers and to become cognizant of a rapidly enlarging world, in short, to become an independent personality. His chief resentments are called out by circumstances which thwart these fundamental drives. His chief pleasures are called out by achievements in running himself and in finding out about things. His attachment, or affection, is directed toward the person or persons most closely associated with these satisfactions, and, of course, with the primitive satisfaction of bodily comfort, such as food and warmth, although these gradually assume less relative importance.

Fear, as has been said (see page 541),is produced by the sense of inadequacy to meet situations which threaten the safety of the organism. Fear produces two protective reactions, withdrawal and attack. At first the infant struggles to withdraw from the source of pain; if this is impossible violent resistance, striking, and slashing occur. The two-year-old first runs from a recognized source of pain such as impending punishment, but when overtaken and held he may strike out at his captor. These two methods of fear reaction may become definitely incorporated in the personality configuration of the child who is repeatedly subjected to the emotion of fear. One child will become belligerent, a fighter, an extrovert, another may establish the habit of withdrawal and become timid and cowardly, an introvert. The preponderance of one method of reaction over the other may be distinguishable very early. The tendency to emphasis on resistance or withdrawal is doubtless to some degree inherent in the constitutional organization of the child. It is also doubtless true that this inherent tendency may be influenced in either

direction by experience. A naturally timid child may have his full capacity for courageous reaction encouraged and developed and thus achieve a well-balanced personality; on the other hand, a naturally courageous child may be subjected to painful experiences so much beyond his maturation level and capacity for adequate reaction that his spirit may be permanently cowed and broken.[1]

The three-year-old child will have established both more varieties of emotions and more intense emotional reactions than he showed at two. His satisfactions are now extended to include not only physical comfort and physical freedom and pleasure in association with familiar persons, which were his chief satisfactions at two, but also association with children of near his own age, and creative, constructive, planned activities, such as things he sees others do, building, drawing, modeling, and to this should be added the intellectual satisfactions of accumulating information—facts, "what" and "why"—and of ownership.

His "dissatisfactions" comprise not only fears, which now cover an increasing range, and restraint of movement and freedom but a widely increasing range of personality reactions. The child at two is thrown into rage by restraint of physical liberty, and may contract a more or less permanent resentment configuration known as negativism. He is more or less resentful of violation of property rights; jealousy may be aroused by certain situations. With his increasing socialization at three, involving intimate sharing of the experiences of his associates in the home, some approach to vicariousness or sympathy begins to appear. Jealousy is more easily aroused; possessiveness may be developed to a degree which leads to the common application of the very vague and unscientific term "selfishness." The experiences of the child, as affected by the mother's policies and attitudes, may veer in the direction of hypersensitiveness to displeasure, of "tenderheartedness," or of the opposite, as extreme disregard of suffering, or "cruelty."

At this age the emotional "sets" or attitudes of the child are forming rapidly. It is of the utmost importance that the mother,

[1] Marston, Leslie R., The Emotions of Young Children, *Iowa Studies in Child Welfare*, Iowa University Press, 1925; Fisher and Gruenberg, *Our Children*, chap. XIII, Anger and Fear as Assets, by William E. Blatz, Viking Press, Inc., 1932.

as one aspect of her intellectual companionship and understanding fellowship with the child, should protect him from injury to his personality through establishment of distorted or unbalanced emotional trends.

The resultant outstanding caution is that we avoid establishing extreme likes or dislikes for persons. The parent should encourage interest in doing things and interest in discovering the meanings of the phenomena of human relations in so far as the child's development permits him to grasp such meanings. This entails, in general, answering questions. All the child's experience and learning should be as impersonal as possible. He is not a "bad boy" because he pulled the cat's tail. It was too bad to pull the kitty's tail and make her cry; *his attention should be focused upon the act and not upon himself.* Johnny, down the street, is not a "bad boy" because he uses questionable language. "Certain words which Johnny uses are not nice words and for this reason we never use them in our home. Sonny will not say words which we never use." The child, at this undiscriminating age, should not be permitted to begin to separate moral sheep from goats, and classify his acquaintances as "good" and "bad." The perfectly natural next step in that case is the protective impulse to keep himself, by fair means or foul, in the favored class! It is much better pedagogy to stimulate impersonal interest in learning about human actions and their effects whether the actions be his own or those of another. The child should be assisted in acquiring experience which will enable him to see all round an act and its consequences and *formulate his own judgments.* Especially he should be helped to view his own behavior as if it were the behavior of another. Who has not wished that he might "stand off and see himself?" "Oh wad some power the giftie gie us, to see oursels as ithers see us!" This power may be established in large measure by beginning with the very young child. The judgments of children whose minds and emotions have not been distorted by fear or warped by the biases of their adults are astonishingly true and trustworthy.

This impersonal policy should extend through all the years of parental association and influence. It has its active inception, however, during this period of early socialization. Nothing is more difficult to retrain than wrongly "conditioned" emotions.

Building, Modeling, and Drawing.—Imitation and imagination are coming into ascendancy during this delightful year and, like



FIG. 138.—A homemade climbing tower which has many uses.

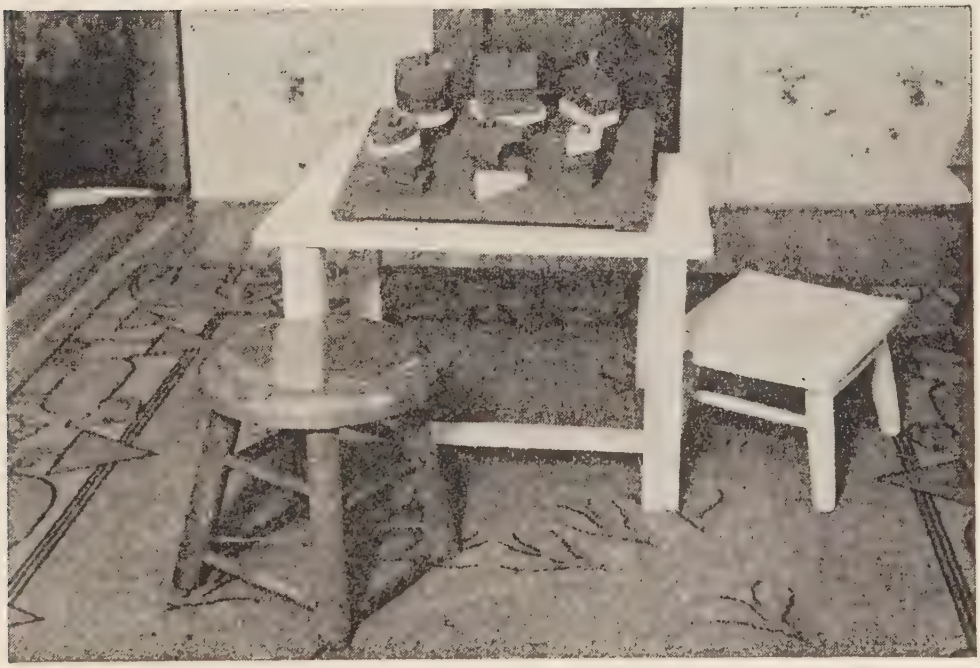


FIG. 139.—Two homemade easels in use.

every other new-found faculty, must have outlet and expression. The child's mechanism of coordination is maturing rapidly.



(*a*)



(*b*)

FIG. 140(*a*) and (*b*).—Spools of all sizes and various types of pegboards are always popular.

He needs materials for constructive effort: building materials such as blocks and boards; hammer, saw, and nails; spade, shovel, and hoe and a place to dig a cellar, cave, or pool or make a garden; modeling material: wet sand, mud, clay, or plasticine; an easel, large sheets of paper, a blackboard, paints, brushes, crayons, and always and especially, at every age, "creative junk."



FIG. 140(*c*).—A general view of the wonderful island showing Captain F. R. W.'s ship at anchor. Pegboards used in dramatic floor games. (*From H. G. Wells, Floor Games, Small, Maynard Company.*)

Large peg-boards lend themselves to endless creative and dramatic purposes.[1]

This may sound like a formidable list, but the articles may be gradually assembled at very small cost. Simple constructive materials have great educational value. Commercial toys commonly have very little. A load of mill-ends and grocery boxes with hammer, nails, saw, and a box of small junk will provide perpetual outlet and activity for any child during any stage of the period in which he actively imitates, imagines, and "creates."

[1] WELLS, H. G., *Floor Games*, Small, Maynard Company, 1912.

The need for a plastic medium of expression arises early. The country child makes "mud pies." The poor city child must be given clay or plasticine and *a place must be provided in which he may learn creatively "to feel the shape of things."*

The writer when visiting the Indian pueblo at Taos came upon a group of small children about three years old playing at the edge of a shallow stream. One had a heap of wet dirt which she was shaping with her tiny hands, while the others were washing bits of cloth in the stream—just as all the three-year-olds of the world were doing (if they had the opportunity) at the same moment. The developmental drives are universal and intrinsic.

Drawing and Painting.—The graphic arts preceded written language phylogenetically (see page 531); therefore we expect the child (ontogenetically) to draw before he writes. We find the manner of using the pencil at the various age levels featured throughout the normative summaries (chap. XXXVII). Opportunity to use pencil, crayon, and paint with the large free movements which are natural to the child should be provided. A wall blackboard provides a cheap and satisfying means of scribbling and drawing with white or colored crayons (see Fig. 136).

The homemade easel is one of the most valuable items of play equipment (see Figs. 136 and 138). A roll of newspaper stock will provide drawing paper for all the preschool years. A mother who dates each used piece and lays it away in sequence will have an interesting "graph" of the mental development of her child.

The primary colors in water-color paints can be purchased at small cost. These may be mixed in fruit jars, and the row of colors with a jar of water for holding and washing the small brushes should stand in the tray of the easel. A small rubber apron hanging on the back of the easel completes the outfit.

No effort should be made to train or direct the child's use of graphic equipment (aside from the orderly care of this as of all possessions). He will use it as he feels the need of coordinating eye and hand, and as an expression of his developing concepts of form and color.

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CHAPTER XXXIII

THE FOUR-YEAR-OLD

This then is the torrential force that comes unbidden out of the mysterious recesses of personality and fashions things out of wood, color, fabric, clay, and words; the thing that dances, sings, leads a dozen dramatic incarnations; the thing that drives a small child into profound research or sets him digging into a difficulty with the energy of a dog in a woodchuck hole; whose ways are sure and whose outcome is beauty.

HUGHES MEARNS.[1]

In general, the four-year-old has extended his three-year-old reactions in all directions. His motor and language abilities have increased. He is much more adaptive and his personal-social reactions, especially, have begun to feature with heightened intensity.

As we think of the theory of gradients and consider the pictures we have drawn of the development of behavior we can almost visualize the rise of definite gradients out of the basic developmental matrix, somewhat as follows: At one year *manipulation and locomotion* dominate the picture of growth, bringing with them new phases of experience and activity associated with the ability to move from place to place. At about two *language* comes into the ascendancy, and the suddenly increased power of formulating thought and of understanding others and of exchanging thought with others lifts the child out of the "chimpanzee stage" of development and makes of him an independent, *thinking*, being. At about three what might be termed the *mechanical-social integration* of the child becomes the focus of developmental growth, and we see him earnestly participating in the established activities of his household and sinking roots of automatic behavior or habits, and accumulating facts about the way things are done and how things actually are in the world, with which he is to think and reason in the future. *He is acquiring the tools of thought.* At four we see our child ready to begin

[1] From *Creative Power*, Doubleday, Doran & Company, Inc.

to take his place as a responsible member of society. We may call this the period of the rise and dominance of the *associative gradient*, producing *reasoning and imagination*. He is not only actively interested in shelling peas and preparing them for the table, carrying them to the table, and serving them, but he wants to know why we do not eat the pods; why peas must be planted in the ground to produce more peas; why we gather more than we plant; what "grow" means; why salt and butter are added, and so on endlessly. He becomes interested for the first time in bringing others into his experiences. He is still vague in his discrimination between the animate and inanimate objects of his acquaintance. It may easily be that he has actually a closer sense of companionship with his teddy bear, dog, or doll than with even some of the members of his own family, who may have actually spent fewer hours with him, and figured less actively in his thoughts.

With the rise of imagination and associative organization the ability to transfer and project his own feelings to others becomes possible. He may, at times, when his attention happens to focus in this direction, become deeply solicitous about the well-being of others—but this solicitude is as apt to be directed toward his doll, dog, or favorite toy as toward his mother or baby sister. Two children about four years old were vaccinated in their home; while the rest of the family were receiving attention they went away and returned with their dolls and insisted on complete duplication of the procedure even to the scratches and the celluloid shields. If they were to be "kept from getting sick" they desired the same protection for their beloved companions.

Where there is illness in the home children in the period of imaginative ascendancy are often found dramatizing the occurrences of the sick room with their dolls and pets. This is in part activity outlet but also in part social concern.

Two children who had been taken to visit a new mother and baby were later found, one in bed with a doll on her arm, the other bustling around. The one in bed calmly remarked, "I've just had a baby and Sis is my nurse." The nurse in question was taking her duties very seriously.

Whereas the child between two and three will set a tea table and put a doll in a chair and pour and drink endless cups of

make-believe tea, the child nearing four is more apt to bring another child, adult, or her dolls into the plot and pour tea for her companions and apportion the imaginary cake and carry on conversation.

The child from two to three may happen to see the six-year-old brother stealing sugar. It will not occur to him that the event is of interest or importance, except as it may suggest to him that he may do the same thing—otherwise he will probably go along about his business. A year later he will more than likely exclaim about the naughtiness of the act and "run to tell." He has discovered that acts mean something, that things are not only done (and a year before it was the doing that was interesting) but that there is a reason for their doing.

This is the time the child begins to ask "where did Mrs. Brown's new baby come from?" If the unmodern adult is luckless enough to say "God gave it to her," the next question will be "Where did God get it?" "God made it." "Did God make everybody?" "Yes." "Who made God?" "Where does God live?" "Can we go to see God?" etc.

The four-year-old child runs to associations. It is as if the cortical cells, having been abruptly connected with each other by the closing of many circuits of dendritic connections (as described by Coghill, were busy setting up configurations, seeking "insights" all over at once. This takes the form not only of organizing new experiences to form meanings, but the recombining in memory and mental imagery of former experiences in fleeting and more or less temporary, so-called "imaginary" wholes, configurations, or situations. The child may require considerable time, even several years with some, to become able to distinguish clearly and always between the real and the imaginary. This should be recognized by the adult as a normal developmental phase through which the child will come by the simple process of maturation. There is no more danger that the child will continue to confuse mental imagery and reality than there is that he will continue to climb stairs on hands and knees.

The fairy story begins to have appeal at this time. The fairy story doubtless arose empirically in an effort to elicit and hold the interest of the child at this stage, combined with an effort, in some religious myths, to convey moral lessons. Indeed, it is

often difficult to determine whether the child actually confuses real and imaginary occurrences or whether both merely seem equally valid and are equally enjoyable to him. He often becomes insensibly aware that Santa Claus is some one he knows dressed up, but he enjoys the make-believe quite as much as the myth, and often the mother cannot tell when the child first became aware of the deception.

Jack's Bean Stalk which grew skyward at such an impossible rate is such good fun that it does not make any difference to the child whether it is true or not. Two children were comparing notes about two little pitchers which had been given to them. "Mine is the biggest." "No, mine." "Mine is so big Mamma and Papa and everybody can drink from it." "Jesus can drink from mine," retorted the other. Not to be outdone, the first one terminated the argument by saying, "Mine reaches clear up through a hole in the sky and God drinks from it." All with two small pitchers before them!

The maturation of the associative mechanism naturally makes associative memory suddenly and freely possible. This must, like all functions, be developed and trained by experience. The child happens to overhear some one relating an experience with a strange dog on the street. A big black dog is impressively described who tore a hole in the woman's coat. This may be dramatically repeated by the child when he goes to visit his grandmother the following day, except that the child in all seriousness says, "A big, big dog, *black* dog, bit hole in Johnnie's coat." He may insist upon the truth of the story, and may repeat it to several others. He instinctively visualized himself in the situation and this relationship leaped into reality for him.

Nothing is gained by confusing the child with emphatic correction which implies that he should not have said what he was impelled to say. Experience seems to show that the adult may possibly help the child to some extent by quietly remarking "was it *your* coat really, or was it Mrs. Brown's coat?" or "You're just *playing* that it was your coat, aren't you?" There should be no rebuke in the tone, and if the child insists that it *was* his coat, it is better to accept the tale without further comment.

In general, the three-year-old wants to share the *action* life of his associates, while the four-year-old begins to want to share

their *thought life*. He is becoming aware of an inner world which is not clearly defined from the fascinating outer world. This is a charming age, and blessed is the adult who has the opportunity and the insight and the delicacy of imagination and response intimately to accompany a child throughout his fairy-land years.



FIG. 141.—The four-year-old wants to play with other children.

The normative summaries for four-year-olds are given in chap. XXXVII and may be somewhat more extensively stated as follows.

In motor development the four-year-old manipulates with greater deftness and sureness and can negotiate more difficult situations. He can climb high in a tree and turn around and come down where he would have required assistance at three. He can hippety hop, leap on one foot, and, if he has been encouraged, turn somersaults. He glories in motor adventures, such as climbing the under side of a ladder and walking the ridge pole

of the garage. He has better command of his clothing, brushes his teeth more efficiently, can lace his shoes, but is probably still uncertain about tying the knot.

The four-year-old puts toys or other articles in place much more speedily than at three and is somewhat more apt to restore things to proper places without suggestion. Many things which were new and experimental at three are becoming automatic at four. He requires fewer reminders and fewer trials in hanging up wraps, washing hands, and wiping up spills. The four-year-old negotiates the walking board more successfully than at three, placing the feet before each other alternately, whereas the three-year-old tends to shuffle along.

Baldwin found that two-year-olds were entirely unable to build a Montessori tower of blocks, while the child at three built it in an average of 110 seconds, and the child at four averaged 42.4 seconds.

Baldwin also reports that the average child at two years placed the blocks in a form board successfully in 257 seconds; at three years he required 76 seconds, and only 38.1 seconds at four. At five years he had reduced this time to 30.4 seconds.[1]

Language and Thought. *Vocabulary.*—Four-year-old children increase the vocabulary rapidly with the rise of associative thinking. The Brandenburgs found that the child studied increased her vocabulary 52 per cent during her fourth year, starting with 2,282 words at four and ending with 3,915 at five. They found that this child at forty months used an average of 950 words per hour and asked an average of 376 questions per day. At no time was she silent for longer than four minutes. At fifty-two months she uttered 14,953 words during the day, or an average of 1,244 per hour; she asked 397 questions per day or an average of 33 per hour.[2]

Descoeudres in a comparative test of French children of upper- and lower-class parents reports that four-year-old children of the wealthy class averaged 2,216 words in their vocabulary, while those of the common class averaged 1,896 words.[3]

[1] Baldwin and Stecher, *Psychology of the Preschool Child*, p. 86, D. Appleton-Century Company, 1924.

[2] Brandenburg, G. C. J., Language Development during the Fourth Year, *Pedagogical Seminary*, vol. 23, 1916.

[3] Descoeudres, A., Development of the Infant from Two to Seven Years,

Nice reports the all-day conversation of one four-year-old child. During the day she used 1,135 different words, but uttered a total of 5,519 words during the 6 morning hours and 4,999 during the 7 afternoon hours. She used 2,686 sentences averaging 3.9 words each and asked 300 questions, or an average of 23 per hour.[1]

Time.—The four-year-old is becoming oriented in time as well as in space and in social relationships. He may know (of course only if he has had opportunity to learn) the difference between forenoon and afternoon: he knows that breakfast, lunch, and dinner succeed each other; he knows yesterday, today, and tomorrow, and he is learning the significance of the days of the week. Obviously he cannot go beyond his memory span, and accurate memory for seven consecutive days is a considerable feat. Holidays will stand out longer in the memory than other days, and stories and pictures supplement memory images until the child builds up concepts of Christmas, birthdays, etc. He begins to be interested in the progress of the hands around the face of the clock and to recognize its meaning although he cannot, of course, read the figures. He readily learns that when the hands are at certain marks he is expected to go to bed.

Distance begins to assume definiteness in that the four-year-old understands the meaning of near and far, and of block as meaning from street to street. Although he may not try to name them, he is able to indicate which of two objects is nearer to him. He is able to discriminate small units of difference in size, length, and weight.

Number also has meaning at this age. One of the Stanford-Binet tests for four-year-olds is the ability to count four pennies. Kuhlmann, however, places this test at five years. Although not actively conscious of number configurations the child may arrange blocks or marbles in groups of two or three. He may count verbally in sequence as far as six to ten. He may count with marbles as far as nine.

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reported in the *Twenty-eighth Yearbook of the Society for the Study of Education, Studies in Language Development*, p. 506. Quoted by permission of the society.

[1] Nice, M. M., Concerning All-day Conversations, *Pedagogical Seminary*, vol. 27, 1920.

Colors.—At four the average child can name eight colors. The studies of color preference seem to show an early preference for yellow changing to red, and later to blue.[1]

Adaptive Behavior.—The four-year-old can now make his behavior conform to more complex patterns. At two he scribbled aimlessly according to the direction of greatest ease of movement. At three his scribbles became somewhat formed and he may decide that he *has* drawn a man or house. He may actually have drawn only a head, a hand, or a chimney. At four he may announce that he *is going* to draw a man or a house and produce recognizable likenesses with most of the essential features present.

At four he will complete a picture in which the head or arm is missing. Gesell says he will add three missing features. He will try to wrap up objects in paper. If the plates are placed upon the table he can lay the silver very accurately. After the table was set one four-year-old heard his mother invite a playmate to stay for lunch. She soon afterward discovered him adding a plate and service to the family table for his guest and doing it entirely correctly and without suggestion.

The child at four can be trusted to carry out small errands, although, since his sense of the lapse of time is not yet well developed, interesting diversions may delay his return. The important thing is that he is mentally responsive to the idea of sharing in responsibility.

Personal-social Behavior and Training.—It is in its personal-social aspects that the behavior of the four-year-old is most significant. As has been said, he has achieved personality orientation in that he has *discovered himself;* he has achieved *spatial orientation* and is making the acquaintance of his environment and its management. He is now achieving definite *mental and emotional orientation* and brushing wits with his elders. It becomes enormously important that he shall acquire correct attitudes and motivation. "It is more important that he shall *feel* right than *do* right."

The adults in charge of the four-year-old will meet a constant challenge to make correct values appeal to his mind; to help him become able to meet the issues of life fairly and impersonally

[1] Rand, Sweeny, and Vincent, *Growth and Development of the Young Child,* p. 267, W. B. Saunders Company, 1930.

and *independently*. Masterly restraint is necessary to avoid thinking for him. The adult holds the palate of mental colors from which the child selects according to his conscious need. Never should the adult put brush to the canvas of the child. The picture had better be "a poor thing but his own" than a hodgepodge in which the personality of the child is submerged and lost and dominated by the adult.



FIG. 142.—The child begins to turn the leaves of books (thirteen months).

The emotional rapport between parent and child outweighs every other consideration during this thrilling year. The mental-hygiene aspects of his training are now in the ascendancy. His physical hygiene should be so well established as to be practically automatic. The large problem now is to prepare him for his impending excursion into the abruptly enlarged world of school life. In a very real sense the child must be mentally and emotionally weaned if he is to be prepared to meet the exigencies of school life. The mother should ever have this fact before her and ask herself "what would my child do if another child struck him or took away his ball on the school ground or street when I was not there?" "What would he do if another child offered him a bite from his apple, or lent him his half-worn all-day sucker?"

The child must be steadily guided toward autonomy and independence in all the affairs of his small life. During his fourth year he has great need for companionship with other children. This is shown by his gregarious drive, which impels him so strongly that he will brave parental punishment and disfavor to be with other children. Hunger for companionship of other children is the usual cause of running away at this age.

While as a young child he has enjoyed having other children about he has not *required* them in the sense he now requires them. Now he wants to play *with* them in organized, social play. This he must do as preparation for his future relationships with the social group. He should have full and satisfying contact with other children, not only of his own age but of varying ages. Another valid criticism of the conventional nursery school as organized at present is that the age stratifications are rigid and

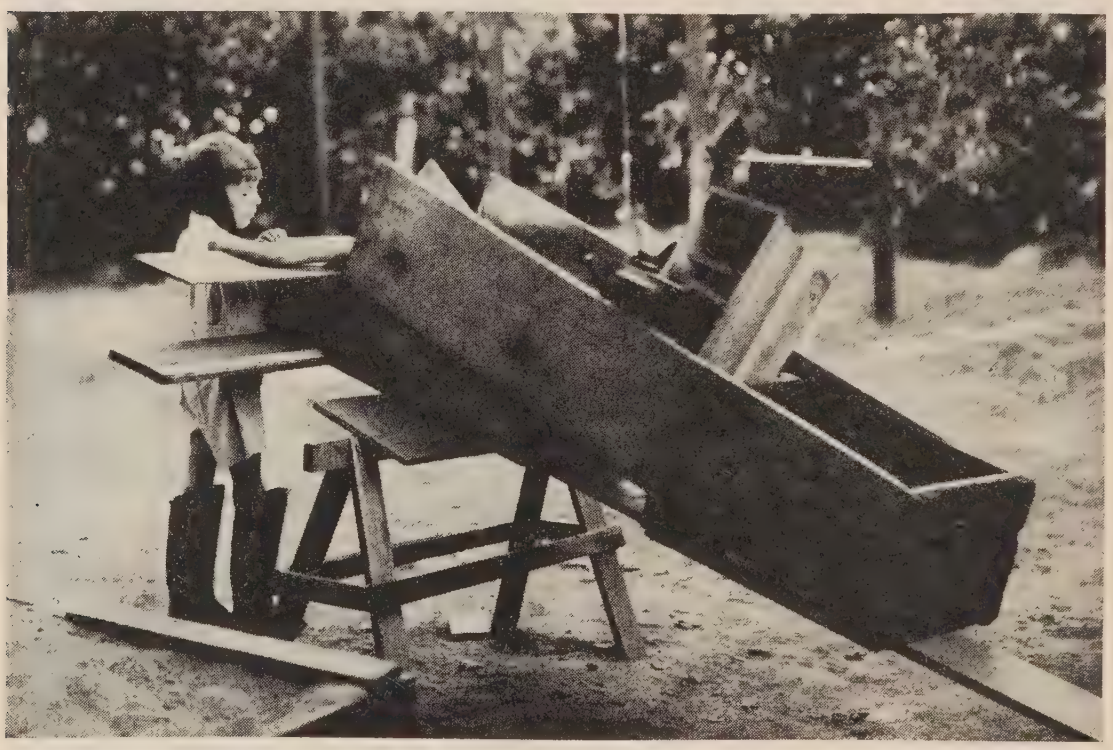


Fig. 143.—The five-year-old loves projects. This boy drew his own plan and built this airplane without assistance. He had recently had a trip in an airplane and had used tools since he was two years old.

tending to become more rigid as larger groups are involved. While the child should learn through experience to hold his own with his own age he should also learn through experience to adapt to younger and older ages. The mother, for this reason, should seek opportunities for him to be with mixed groups and discover how to adapt to the child who is weaker and to the child who is stronger than himself.

Here as elsewhere the adult should keep hands off and, as far as possible, permit the child to make his own adjustments and fight his own battles. One of the great virtues of the nursery school is that it provides a laboratory of social experience for

the child. Under the safe experimental conditions provided the *child trains himself* unconsciously and happily to cooperate, to think, to adapt, and to create.

How far the home can adopt and adapt the methods of the nursery school is an important question at the present time. Certainly the home should adopt the methods which are being demonstrated by the nursery school to be successful, whether or not the child spends part of his preschool life in attendance upon such a school. It may be that the use the home makes of these methods and what the home learns from the nursery school will prove to be the most important contribution of the nursery school to child development.

Story Telling and Literature.—The child begins to turn the leaves of books and recognize pictures of familiar objects before he is a year of age. The natural thing is for the parent to talk to him about the pictures. Thus story telling begins, and passes by almost insensible degrees from one-sentence stories such as: "The boy has a red ball," or "The girl's name is Jane," to the colorful dramatizations demanded at four and five years of age.

Pictures and stories are the preschool child's textbooks and should be carefully selected as to character and comprehensive as to scope. The mother should give a great deal of attention to the art of story telling. Stories and pictures do more than merely entertain the child, even at one year. Stories and pictures do much in atoning for the restrictions of his environment, and in shaping his attitudes and emotional sets or configurations.

Therefore pictures and stories should first relate to the familiar experiences of the child and secondly make him familiar with the more remote and casually experienced parts of his environment.

Thus, from pictures of cups, spoons, clocks, chairs, etc., as illustrated in the *First Picture Book*[1] the child passes naturally to pictures (especially for the city child) of the cow who gives the milk; of the barn where she sleeps, the pasture where she eats grass, and so on endlessly, expanding the child's horizon as his thinking and imagination develop.

[1] MARTIN, MARY STEICHEN, *The First Picture Book*, Harcourt, Brace & Company, 1930.

The "here-and-now" type of story, so delightfully developed by Mrs. Mitchell,[1] probably should always predominate, and should be so employed as to round out the child's experience and information in a symmetrical, educational manner, always following and capitalizing any immediate curiosity or interest on the part of the child.

There is, at present, a rather active controversy relative to fairy stories, with "Mother Goose" as the storm focus![2] Most observers seem to agree that during the period of the active rise and ascendancy of imagination, the child needs make-believe stories, as he needs and employs make-believe play. This need and the observed appeal of fairy tale and myth are, doubtless, features of the recapitulatory experience of the child, who must repeat in his thinking, merely by virtue of his primitive thinking mechanism, some of the phases of primitive culture.

The parent who is trying to follow the lead of the child's maturation will recognize the time to enter joyously, with the child, the land of make-believe. Fairy stories should not replace here-and-now stories; and *fairy stories should never be told to the child as being true stories.* Probably nothing but "true" or "here-and-now" stories should be told the child until he becomes able to make-believe, and able to enjoy the improbability of the unreal.

The child who grieves over lost faith in Santa Claus does so in part because he is bewildered at having been taught two contradictory things as being true. *No child should ever be told an untruth*, certainly not deliberate, unnecessary untruth to the effect that there are giants, ogres, and witches who eat up bad little boys (or a devil who will burn them alive!). "The fanciful tale, when properly told, is one of the greatest *integrators of life.* Stories, of course, are for fun and fun is wholesome."[3]

At the proper stage, however, children gleefully enjoy the most weird, improbable, and fantastic tales of hair-raising escapes

[1] Mitchell, Lucy Sprague, *Here and Now Stories*, E. P. Dutton & Co., Inc., 1921.

[2] Roylace, Elizabeth, The Case for and against Mother Goose, *Children, A Magazine for Parents*, August, 1927; Gruenberg, Benjamin, *Readings in Child Study*, pp. 148–150, Fairy Tales, The Macmillan Company, 1926.

[3] Starbuck and Shuttleworth, *Fairy Tale, Myth, and Legend*, p. 9, The Macmillan Company, 1928.

and experiences. It requires nice judgment and sympathetic contact with the particular child to know when (or if), and how often exciting stories should be told, even when the child fully realizes that they are frank unreality. Fairy tales, myths, and legends should be carefully selected for artistic validity and should be free from crude, vulgar, or cruel characters or action. By this criterion the Mother Goose tales would have to be used *selectively*. Many of them are good, even by modern standards, and have the virtue of having been "aged in the wood" of centuries of child-judgment. A few of the tales in certain collections do not ring true artistically and are rather crude from the standpoint of cultural standards, as when Jack Spratt and his wife "lick the platter clean," or when My Son John goes to bed with "one shoe off and one shoe on."

In addition to here-and-now and make-believe stories, we may add what might be called "diction" or "rhythm" or "nonsense" stories. Small children of all ages enjoy jingling, alliterative, singsong, rhythmic sequences of words which may not make sense at all. These probably have some value in training voice and ear, at least they "tickle the ear," and appeal to the child's primitive sense of humor. Some of this type appeal particularly at the time the child is enjoying reiteration in speech and endless repetition in muscular movement, as in pouring sand from one cup into another. This is the period during which a story must be recounted word for word, with the greatest precision, and repeated over and over again.

Aside from the character of the story, the manner of telling is important. Starbuck and Shuttleworth say:

> Story telling is an art, and the art of it lies in its very artlessness and naturalness. . . . Keep the plot simple, the action swift-moving. . . . Paint pictures of what you see with bold, sweeping strokes and clear, bright colors. . . . Appeal to the senses, make the listeners hear the wind in the willows, the growling of forest animals, the heavy thud of Thor's hammer. Make them see the little white fluff of Peter Rabbit's tail as he scuttles to safety.[1]

In short, pictures and stories, even for the littlest child, should first be good art and good literature, even if only a picture of a red apple and one sentence. The story-teller should use clear,

[1] Starbuck and Shuttleworth, *op. cit.*, pp. 22–23.

correct and forceful language, carefully adapted to the maturation level of the child.

In the second place, pictures and stories must hold the interest of the child. Stories may do this through purely sensuous auditory satisfaction in meaningless jingling rhythm, or by coordinating with his awakening delight in a world of reality, or by fanciful flight into a suddenly expanding world of joyous unreality.

In the third place, both pictures and stories should produce happiness and satisfaction in the child. Nothing should be presented to him which creates in him an actual sense of fear or revulsion, or unduly excites him. The effect should be thoroughly wholesome to nerves and imagination.

Fourthly, it is inartistic and ineffective to "draw morals." If the child does not see the point it is useless to call his attention to it. On the other hand, the behavior situations dramatized in story telling should not focus upon or unduly emphasize undesirable social conduct, both for the reason that the child may be unable, from his limited social experience, to draw correct conclusions or see the situation in its true perspective, and also because it is education of the wrong sort to present to him definite action patterns for trickiness, violence, and crime. This does not mean that only sugar-coated, goody-goody mental pabulum should be given the child. He must eventually come into contact with reality; and story, myth, and legend prepare him "painlessly" for some of life's realities. He should have vigorous, live, dramatic action, primitive and raw at times, in keeping with his primitive stage of development, but through all it should remain true to the life values we wish to have him accept.

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CHAPTER XXXIV

THE FIVE-YEAR-OLD

Every child should have mud pies, grasshoppers, water bugs, tadpoles, frogs, mud turtles, elderberries, wild strawberries, acorns, chestnuts, trees to climb, brooks to wade in, waterlilies, woodchucks, bats, bees, butterflies, various animals to pet, hayfields, pine cones, rocks to roll, sand, snakes, huckleberries, and hornets, and any child who has been deprived of these has been deprived of the best part of his education.

LUTHER BURBANK.[1]

At five years or thereabout we lead our child to the schoolroom door, and he enters upon a new regimen which is to dominate his activity and his thinking for at least 10 years, and possibly 20. Is he ready for this change? Let us scrutinize his development from the standpoint of the demands his new life will make upon him.

Physical Care of Self.—He should be able to go alone for a reasonable distance on familiar streets; and to run and climb and avoid dangerous situations. He should be able to take care of himself completely, get a drink, go to the toilet, wash his hands afterward without reminder, take care of his own wraps, clean up his own play débris, willingly put things in their places, and assist the teacher in care of room and equipment.

He should be responsible in the care of his health—about putting on wraps before going out to play; not drinking or eating after others; not putting pencils or fingers in the mouth, etc.

Language.—At five years the child should enunciate clearly, use complete sentences, and state his full meaning. He should be able to narrate a complete occurrence and repeat a familiar story. The habit of narrating experiences within the family circle should have been encouraged and developed, so the child will feel easy and free in describing the experiences of the schoolyard and street. He has a well-developed sense of humor. His imagination is in the ascendancy. He is able to differentiate

[1] *Training the Human Plant* D. Appleton-Century Company.

between imaginary and real, although strongly under the spell of "make-believe," and with proper training is fairly reliable and truthful. He asks many questions, which gradually become more penetrating in his search for causality. His knowledge of



(*a*)



(*b*) (*c*)

FIG. 144(*a-c*).—Every child should have *brooks to wade in.*

time, space, number, form, and color has increased. He usually has well-defined appreciation of tune and rhythm.

In adaptive behavior the five-year-old who has had the type of educational experience previously presented in this text will cooperate, without very much reminding, in watering the plants,



(*d*) (*e*)

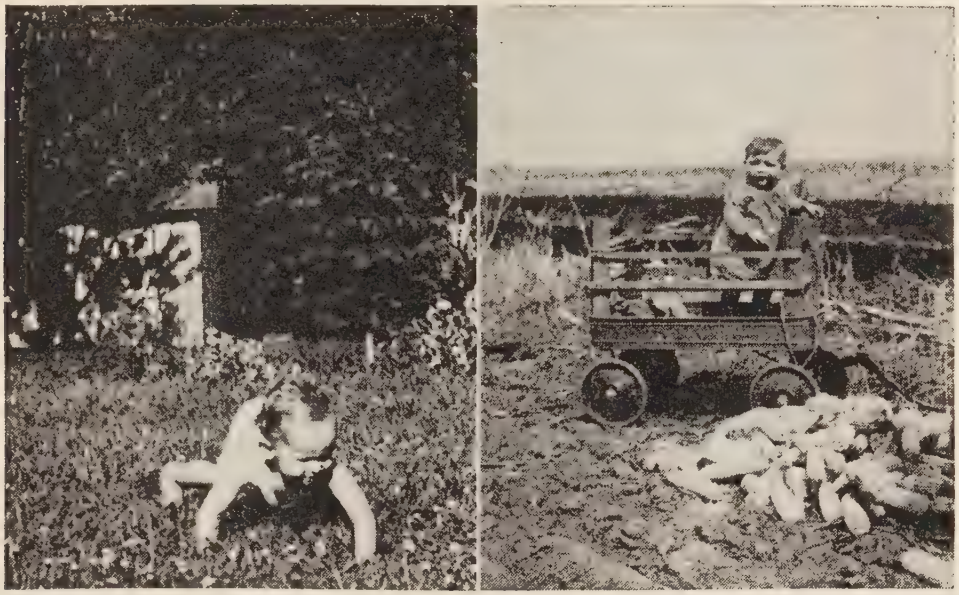
(*f*) (*g*)

(*h*) (*i*)

FIG. 144(*d-i*).—Animals to pet.

caring for pets, and in putting things away. He can remember and carry out three or more verbal commissions.

He draws and builds purposefully with a plan or design in his mind. His mental visualization is more accurate and extensive than previously. His associative memory has developed much



(*j*) (*k*)

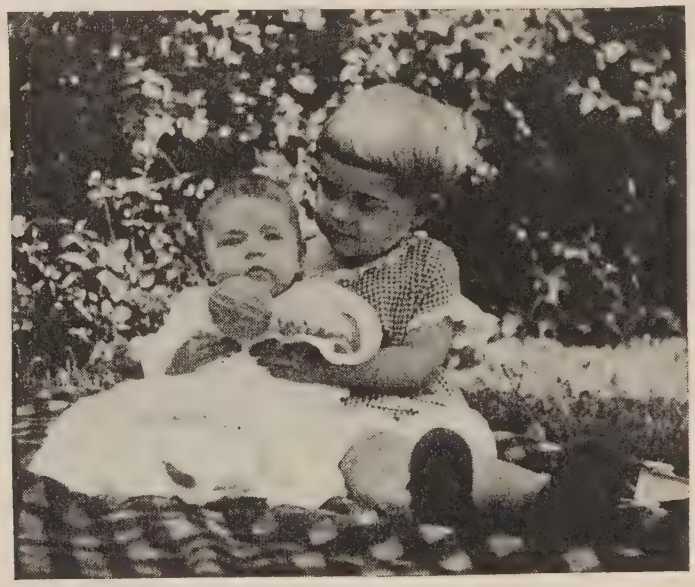


(*l*) (*m*)

FIG. 144(*j-m*).—Wild strawberries—grasshoppers—hay fields—frogs.

during the year. He picks up new words like a chicken picking up corn. He loves to repeat them, and his attempts to give them meaning are sometimes so ludicrous it is difficult not to laugh at him. The child should not be subjected to embarrassment, however. If a definition conveying any sort of meaning to him can be given when he uses a new word, this should be done. His

experimentation with grown-up language should be treated matter-of-factly and casually and helpfully and without too much attention or seriousness. The child is reaching out for larger



(*a*)



(*b*) (*c*)

FIG. 145(*a-c*).—Responsibility for "Our Baby" makes a difference.

thoughts, and, as always, he must have time to acquire configurations or wholes of meanings. In keeping with his expanding interests, he is awakening to meaning in all living phenomena. The growth of plants, the blossoming of flowers, the birth of

kittens, the new baby, mating birds, insects, worms, fish, running water—all are entrancing. All living phenomena are of equal beauty and equal interest. He has acquired (we hope) no prejudices, shames, or artificialities of judgment. A dirty alley kitten is as priceless to him as a pampered Persian; a toad or a green tomato worm as desirable and interesting as a goldfish. He should be so well informed and well satisfied about natural phenomena, especially sex facts, that surreptitious experiences will not have special appeal, and his home relationships should be such that he will have no embarrassment or reluctance in telling his mother anything that occurs at school.

In social behavior the five-year-old should be able to settle many if not most of the difficulties which arise between himself and other children. He should be cooperative and present no disciplinary problem to his teacher.

The child of five is beginning to glimpse the larger relationships of life. He sees that people live together as neighbors and that a lot of people live near each other to form a town or city; that these people obey some head as do the members of a family. There is the father in the family, the superintendent in the school, the pastor in the church, and the mayor in the town. Some children at this age even grasp vaguely the idea of state and nation, but only if their experiences have given them some concept of larger spaces through journeys, pictures, or stories.

If properly developed along the line of actual experiences the child of five will have a real sense of respect for authority and will realize that everybody minds some one higher up. He should, if possible, know and have friendly relationships with the policeman, mailman, and other municipal officials, and be interested and intelligent about their respective duties.

Socially the child is beginning to force himself into human relationships. He organizes simple group play with children of his own age and younger, and he insists on being taken into the group activities of his older brothers and sisters. This is invaluable training in social adjustment. He becomes constantly and increasingly aware of conflicts between his motives and desires and those of *others of equal authority*.[1] Up to this time

[1] CURTI, MARGARET WOOSTER, *Child Psychology*, p. 311, Conflicts, Longmans, Green & Co., 1931.

conflict of desire has occurred chiefly between himself and persons larger and older who insisted upon dominating the situation. *Now the conflicts are between equals who must find ways of their own for settling difficulties.* This is a distinct phase of experience and marks another increment of maturation.

Nursery-school children come upon this experience earlier than children who have lived quietly in the home until entering the public school. Nursery-school children, however, require more assistance in making their adjustments and are more apt to call upon elders than are five-year-olds.

Problems Are Important in Development.—The child's mental growth depends upon solving problems. It is a mistake to shield a child from difficulties which he is mature enough to solve. It is an even worse mistake to permit a child to be baffled, bewildered, and discouraged by problems which he is not developmentally ready to master.

Training.—The training from four to five should be directed toward mental and emotional weaning, preparing the child to get along without his mother, to think for himself and do for himself. He should be prepared for the experiences school life is certain to bring.

Adaptation to School Life.—*The daily schedule* should have been gradually changed in anticipation of any necessary adaptations when the child enters kindergarten. His bedtime should have been thoroughly established at such an hour that he awakens spontaneously early enough to eat a generous breakfast in a leisurely, happy manner, have his accustomed bowel movement, and set out for school in a tranquil state of mind. Too often the entrance of the child into school life ends tranquil, happy days for him and initiates a long sequence of days of pressure and hurry. "You must get up and get ready for school!" "Hurry up and eat or you will be late." Then the visit to the toilet is omitted some morning when things lag, or the child is too tense to have satisfactory results, and a period of cathartics and nervous and physical upset follows.

The quiet, tranquil initiation of the child into his school life without interruption of any of his health habits is of critical importance.

The sleep program of the child should have been adapted to the hours of the impending school period long in advance of

school entrance (see page 357). Most children of five have dropped the midday nap, but need to observe a very early and very regular bedtime. This should be *thoroughly established* in anticipation of the excitement of the new experience, which may make it difficult for him to go to sleep at first.

Every growing child of any age should have a period of regular midday rest even if brief. The mother should take special pains to have her kindergarten child observe this happily and quietly. Fortunately the customary half-day session makes this easily possible.

The food needs of the child entering school should receive careful attention. *Breakfast is the key meal.* Breakfast on the first day of school is the most important item of the eventful day and determines in considerable measure the degree of fatigue experienced by the child. The mother should be prepared to see that her child does not fall into irregular and perverted food habits.

The temperamental adjustments of the new school-child are also most important. The child who has had nursery-school experience, or who has had an abundance of opportunity to play with other children, will have little difficulty. The mother may, however, have more or less frequent opportunity to act as friendly mediator and interpreter to her small child in regard to new situations and difficulties which arise on school ground and street. She can do much to help her child in developing an independent, courageous, and impersonal attitude toward life and to prevent the entertainment of self-pity or development of egocentrism. With the rather sudden expansion of social contacts and with accommodation to the personality of the teacher there may be intensification of extrovert or introvert tendencies which call for tactful management.

In short, our five-year-old is, or should be, an independent human being with the habits and attitudes quite firmly established which he will carry through life.

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CHAPTER XXXV

THE RELIGIOUS, AESTHETIC, AND MORAL TRAINING OF THE YOUNG CHILD

When you say that if I allow not in God the operations of seeing, hearing, observing, willing, and the like . . . you know not what sort of God mine is, I thence conjecture that you believe there is no greater perfection than such as can be explained by the attributes aforesaid. I do not wonder at it; for I believe that a triangle, if it could speak, would in like manner say that God is eminently triangular, and a circle that the divine nature is eminently circular; and thus would everyone ascribe his own attributes to God.

SPINOZA.

The Little Child's Religion.—Man has always created God in the image of his loftiest concepts of the universe, nature, and human relationships. At first a God of magic powers who could create a world and people it in seven days, a God of arbitrary human qualities, a "jealous God, shewing mercy unto those that fear and obey him" and "vengeance" unto those who disobey his "commands." The God of a "chosen people."

Every race and every people has conceived a God, a Creator, a Force behind the universe. This seems to be an organic evolutionary compulsion. The new dispensation of Jesus introduced a very human-like and very personal God of Love whom human creatures accept and admire although they blunderingly go about showing intolerance, cruelty, and selfishness each after his own pattern.

Modern science has enlarged the human concept of the universe and has entirely removed man from his former assumed position as center of creation and made him appear to be a very trivial, insignificant item in a creation so immense that the highest thought of man can not even faintly conceive of its bounds.

Humanity is under the necessity at the present moment of "getting itself a bigger God," one who conceived and projected not only our humanity but doubtless numberless humanities on countless worlds. The modern scientist is not an "atheist";

he is of all people the most reverent, the least dogmatic, the most humble.[1] The modern scientist is entirely willing that each human being should believe in his own concept of God and bring his children up in his own belief.

Granting all this, there are certain aspects of our accepted developmental theory of training and education which may be applied to moral, aesthetic, and religious training in the form of fundamental precepts.

1. *At each level of development the child should look out upon his expanding world with tranquillity and joy.* This means that he is not afraid, that he is comfortable and well nourished, and that he finds continual interest and stimulation from his enlarging experience.

2. *The child should find his world of sensory impressions beautiful.* Simply by exposure to beautiful sounds, odors, colors, and movements, he should insensibly acquire appreciation of beauty. There probably is no greater safeguard to character than genuine love of beauty woven into the warp and woof of early experience. One cannot easily think narrow, selfish, bitter, or cruel thoughts while responding to the spell of a beautiful sunset, a symphony, or the charm of a rose.

The sharing of beauty in the form of nature, music, art, or poetry is one of the subtlest and strongest bonds in family relationship. It has aptly been said that families whose members "play together, stay together";[2] it is equally true that the members of families who enjoy beauty together will feel thereby a more definite sense of companionship. This does not mean that the individuals must necessarily be performers or artists. They may only listen together to good music on victrola or radio, or to concerts, or enjoy pictures together or, especially, seek beauty

[1] Cotton, Edward H., *Has Science Discovered God?* Thomas Y. Crowell Company, 1931; also Science Finding God, *Literary Digest*, p. 21, Nov. 21, 1931 (a review of the above).

[2]

One would be in less danger
From the wiles of the stranger
If one's own kin and kith
Were more fun to be with.

Ogden Nash,
Hard Lines, Simon & Schuster, Inc.

in nature as a "shared" experience. The technique of providing the small child with facilities for artistic expression has been discussed, in part, in connection with occupation at the various age levels.

Frances M. Frost has expressed the lasting effect of beauty in the life of the small child in the following charming poem:

Heritage

Let a child live in these hills
Let a child run
Where the small brook twists and spills
Under the sun—
Where the grass in the wind is a surging silver sea
About his feet,
And Beauty leans above him as a tree
Leans when the dusk is sweet.

Let a child live in these hills.
When he is old
He will remember woods where a wild thrush fills
Shadows with a bold
Shower of loveliness. He will walk and dream
Of a strong and darkened crest.
He will keep forever grasses and wind and the stream
And a bird in his breast!

FRANCES M. FROST.

3. *The recognition and enjoyment of beauty are based upon a fundamental sense of harmony which carries over into personal relationships.* The "well-bred" person, the "thorough-bred," the "real lady or gentleman," is an individual who has this fundamental sense of harmony to such a degree that discord or disharmony is repugnant to him in any aspect of life. The child who comes up through his developmental levels in the quietness and freedom implied in the organismic theory of behavior and training, and who has had beautiful, harmonious surroundings, will be apt to have poise and friendliness and a sense of fair play in his human relationships. After all, is not this the profound basis of true morality? The child who lives in an atmosphere of affection and understanding and who thinks for himself without having to be on the defensive and having to fight for his independence is prone to feel friendly and affectionate towards associates and familiars, be they children, adults, actual officials such as teachers, clergy, or policemen, or an all-powerful but beneficent unseen being called God.

4. *Reverence comes very easily to the little child.* He takes unquestioningly all things which are told him by elders whom he trusts. It is no more difficult for him to believe that God made everything than for him to believe that some men made the family automobile or piano. When it comes to answering his specific questions, such as: "Did God make bad people too?" or "Why did God let the church burn down?" the parent will have to answer in a manner consistent with his own religious faith. Organismic educators hope these answers will not create confusion or fear in the child's mind. He will create for himself a world-concept of beauty and harmony if his adults merely stand by and help only as he feels the need of help, and do not lay the heavy hand of dogmatism prematurely upon his delicate and glowing and vital concepts of a wonderful creation. Religious instruction of any and every sort should, first of all, give the child a sense of security. Above all, God should never be held up as a threatening or menacing power.

5. *The matter of church attendance for young children will have to be settled according to circumstances.* Certainly physical and mental fatigue do not conduce to spiritual development or to affection for church procedures. Sunday-school instruction may be good, bad, or very bad, especially for the preschool child. The parent should be certain that the teacher who assumes the religious teaching of a young child is skilled in understanding of the child mind, and certain, especially, that the child will not receive lurid or terrifying mental pictures from the wrong type of portrayal of Biblical events. Rote learning of texts and Scripture which can have no meaning for the child is only confusing and distorting. Religious teaching, like any other, should be true to the maturation of the child's brain. The child who asked, "Where do they keep the consecrated cross-eyed bear?" was reacting at his maturation level but was not being especially "uplifted" by the service!

Religious teaching, like every other teaching, must have the simplicity and directness and casualness of the child's own thinking, and most modern parents would agree that the child may pretty safely be left to build up his own concepts of causality and duty according to his own inclination, if his environment and experience can be kept on a normal and satisfying plane.

Moral Training of the Child.—The word "moral" derives from basic roots meaning habit, custom, "mores." Moral conduct would be defined by the average person as "right" conduct, meaning by "right" his conception of behavior which conduces to the welfare of the entire social group, "the good of all." Obviously the meaning of the term "moral" to any individual is conditioned by his experience in the way of personal relationships, reading, and observations. All such individual concepts taken collectively form a composite of "moral standards" for a cult, a race, or a nation.

The child is without experience which can give him moral concepts. "Right" and "wrong" as applied to his conduct only give him a sense of approval or disapproval on the part of the adult who applies them. The terms can have no concrete meaning for him until he has had extensive experience in seeing the logical results of behavior, and especially until he has arrived at a maturation level such that he can draw conclusions and mentally organize experience in the process of his thinking.

The moral training of the preschool child, according to the organismic theory, consists in helping him to have "complete experiences," involving, in as far as he can understand, the results of behavior. In addition to this, the child should be encouraged *to think for himself* and draw his own conclusions. If his environment provides him with a *moral atmosphere* in which he experiences, in the main, fair play and a show of consideration on the part of the persons with whom he associates, the child can be trusted eventually to form correct moral concepts.

For the very young child "training" should take the form of logical consequences. If he willfully breaks another child's toy, he can understand that he would feel badly if the other child should break a favorite toy belonging to him.

If he runs away, restriction of freedom because he cannot be trusted is a logical consequence.

In so far as possible, as has previously been intimated, the experiences of the child should be kept free from emotional context. He need not be abused and punished and humiliated in order to learn to be "moral." The parent who blames the child and throws emotional tantrums himself when the child violates the adult code is not teaching his child "to love the right."

The author once went into a farm home and seeing a charming three-year-old child made a complimentary remark. The mother said, with offensive emphasis directed toward the child, "But you never would believe what she did yesterday! I went out at noon after the hired men had come in, and there she was, up on the seat of a wagon, before them all—*without a stitch of clothes on!* I tell you I gave her the spanking of her life."

The visitor said, "Just what did you spank her for?" "Why," said the mother in surprise, "she just naturally ought to know better." The chances are that the "logical result" of this experience will lead this child to have a nervous paroxysm and struggle and scream when a few months later she is required to remove her clothing for a preschool health examination.

In general, the term "moral training" is giving way to the term "character training." This is more comprehensive and is freer from the implication of the "immoral" with all its sinister connotations.

What we wish to achieve is well-rounded sturdy character development. We need not think of this as being moral, or religious, or good, or bad. It is rather a matter of symmetrical growth.

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CHAPTER XXXVI

PROBLEMS

To a Naughty Little Boy

With unforgiving haughtiness
We chide your naughtiness,
How dared you try, abandoned little lad,
The thing we so incitingly forbade!
What was it?—stealing jam from pantry shelves?
Well, we do that ourselves.
Not craving jam, nor having any mind to
The villainies our mentors seem inclined to,
But when they arbitrarily taboo them,
Of course we do them!

ANONYMOUS.

Emotional Problems.—Behavior problems of serious or lasting importance should not appear with the child who has been permitted to develop naturally as indicated in the previous pages. Certain emphases or peculiarities in behavior may arise during any period in which the child is experimenting with a new variety of conduct for which he has suddenly become developmentally ready and when he has not had time to integrate this with his behavior pattern, or to achieve a consistent configuration. For example, when a child first discovers that he can exercise an option or choice in a given situation, and suddenly acquires the sense of being an independent personality, he often passes through a period of resistance to authority known as "negativism." This is a period of adaptation for parents quite as much as for the child. Parents often are quite unprepared for their children's ever becoming independent personalities. If wisely managed, this period of adaptation tends to pass over into reasonable cooperation (see page 548).[1] Again, when the child has acquired a reasonably extensive vocabulary he suddenly discovers that two answers are possible, a true and a false. Both are valid as far as his experience and standards indicate, and he abruptly discovers expediency as a sanction and a motivation. A period

[1] REYNOLDS, MARTHA, *Negativisms of Preschool Children,* Columbia University Press, 1928.

of experimentation follows during which he will become permanently conditioned in a tendency toward either telling truth or telling falsehood, according to his experience during this labile period. Under normal conditions, which give the child time to adjust to the new idea, he tends to come safely and spontaneously through a period of what might be termed "experimental lying" and becomes a normally truthful individual.[1]

Indeed, most so-called "behavior problems" may be said to have their basis in the experimental adjustments precipitated by new levels of maturation, with consequent increments of increased activity and experience.

Guidance consists in quietly steering the child in the direction of correct and advantageous integrations of configurations of conduct and habit. The wise parent will not be alarmed at the sudden appearance of undesirable conduct; rather he will quietly study the situation and help the child in a companionable and impersonal way to make correct adjustments. Nothing so surely sets the habit-mold in the undesired pattern as does overemphasis or punishment or the creation of a violent emotional situation.

Certain behavior situations which may become set in permanent undesirable habits have been discussed in connection with the maturation levels at which they tend to appear. A further discussion of a few of the commonest behavior problems follows.

Fear.—Fear has been discussed in most of its aspects. It seems probable that there are no primary fears. Wheeler says, "In general, the source of all emotive behavior, is, as in all behavior, an undifferentiated total pattern." This may become differentiated through internal or through external stimulus. "It is not something added to other activities. It is an aspect of whatever the person is doing at the time, when in the approach to a given goal, the tension is increased, and maintained through intraorganic stimulation. . . . Emotive behavior, then, is any intentional, intelligent, behavior, *energized.*"[2] "The child's

[1] Parents frequently attempt to exact a standard of truthfulness in their children much more precise than their own. This, of course, destroys confidence in both the standards and the parents.

[2] Wheeler and Perkins, *Principles of Mental Development*, pp. 206–207, Thomas Y. Crowell Company, 1932.

fears are specific, not general. Only after exhaustive study may we conclude that the child is in general a fearful or a timid child. In our guidance of children we shall declare the child to be not generally afraid, but afraid of a specific object or timid in a specific situation."[1]

Assuming that fear occurs when safety is threatened and the subject feels inadequate to cope with the danger in question, it is the part of constructive educational method to help the child in so far as possible to recognize and meet or avoid danger without permitting him to experience the injurious emotion of fear. The most devastating fears, however, are not incited by actual dangers so much as by situations which appear casual to the adult, but which engender in the child shrinking, repugnance, and withdrawal. "In training emotions we are concerned not so much with the child's acute fears as with his subtle vaguely felt fears. Frights, terrors, and acute fears are relatively infrequent. Subtle fears, including timidity, bashfulness, lack of confidence, undesirable inhibitions, are important and frequent."[2]

All behavior is chemical in the sense that chemical changes occur in brain and body cells with every thought and every movement. It has been demonstrated by Cannon,[3] Crile,[4] and others that the cortical cells of the brain undergo crination (shrinking) with fading of the Nissl bodies (see pages 443–444) under fear, just as definitely as they do under exhaustion, disease, or surgical shock.

Courage is the attitude produced by a feeling of competency, a belief that one can successfully surmount the impending danger. Or, in the well-disciplined character, a sturdy facing and acceptance of inevitable facts even though these involve pain or sorrow, such as having a splinter extracted, or accepting the death of a relative. The child who has functioned as an independent person all along the way is trained thereby to meet difficulties

[1] *Training the Emotions and Controlling Fear,* p. 9, Boston Public School Document No. 2, 1928.

[2] *Ibid.,* p. 9.

[3] Cannon, W. B., *Bodily Changes in Hunger, Fear, and Rage,* D. Appleton-Century Company, 1929; Cannon, W. B., *The Wisdom of the Body,* W. W. Norton & Company, Inc., 1932.

[4] Crile, George E., *Man an Adaptative Mechanism,* The Macmillan Company, 1916.

courageously. *Normally he has a consuming urge to solve his own difficulties.* Control through fear is devastating to personality in that it tends either to create timidity and cowardice with secretiveness and lying, or to produce in the aggressive type of child defiance, belligerence, and anarchy, which may also be coupled with concealed sense of inferiority, lying, and secretiveness.

Fears are easily conditioned in young children during the labile period in which organization of mental processes is actively taking place, through exposure to situations beyond their developmental maturity. The work of Mary Cover Jones in this field is well known.[1] Among other experiments, Dr. Jones conditioned young children to fear of rabbits by striking a loud, sharp bell simultaneously with the appearance of the rabbit. Later the children were reconditioned by gradually and quietly introducing the rabbit at mealtime, thus bringing it into a pleasant rather than an unpleasant configuration. Dr. Jones finds "direct conditioning" the most effective method of eliminating fears; in other words, associating the "fear object" with a desired or "craving object."

Every mother should be alert to the fear experiences of her child, and she should make every effort to have all fear experiences eradicated or converted into configurations of competency and courage. Where at all possible or suitable the child should be encouraged and prepared to meet and solve the difficulty himself instead of being assured that "mother won't let the bad dog hurt her baby." Tell him he may pet dogs when the persons they belong to are with them, but that he had better not touch strange, lone dogs, since they may be sick and we do not know what they might do.

The children in every home should be instructed in fire precaution and proper behavior during accidents by fire: to roll instead of run if clothing catches, how to call the fire department, and how quickly to smother different types of fire. Every accident

[1] Jones, Mary Cover, The Elimination of Children's Fears, *Journal of Experimental Psychology*, vol. 7, pp. 382–390, 1924; Jones, M. C., A Laboratory Study of Fear, *Pedagogical Seminary*, 1924; Jones, M. C., A Study of the Emotions of Preschool Children, *School and Society*, 1925; and Jones, M. C., Conditioning and Unconditioning Emotions in Infants, *Childhood Education*, 1925.

productive of fear which comes into the experience or observation of the child should be made educational and kept as free from panic as possible. Help even the youngest child to think "what can I do? what can be done?" in emergencies, rather than to yield to helpless terror. Especially, the child must not become conditioned to being passively rescued from danger.

Jealousy is the reaction which occurs naturally when the child's egoistic integrity—the self-configuration which his life experiences have established—is threatened on the side of his affection or love. He is led to conclude from the evidence of changes in the relationships between himself and others whom he loves or admires that he is to receive less than belongs to him in the way of affection or attention. It is the counterpart of the feeling of resistance and resentment when one's tangible personal belongings are taken away from him. He has just as definite conviction of ownership in one case as in the other.

The situation oftenest arousing jealousy is the arrival of a new baby. The toddler has been led and even encouraged to regard his mother as his own personal exclusive mother, belonging to him in a sense differing from her relationship to any one else in the world. He cannot help being bewildered and resentful when a little crying, red-faced, uninteresting intruder seems to step into his place and rob him of his "very own truly mother." This is an illustration of the wisdom of guiding the interest of the awakening mind and emotions away from the personal. The child who is interested in events and what people do, rather than in the relation of persons and events *to him*, is far less likely to experience personal resentments and jealousies. He will be so interested in what is going on that he will not take so much notice of the necessary absence of small accustomed attentions.

Of course the wise parent will have forestalled any such reaction by bespeaking his cooperation and help and emphasizing the fact that it is "our baby" whom we must all care for with equal sense of proprietorship and responsibility (Fig. 145). *This does not leave the toddler out of the drama; it gives him a part.* This is his right as a member of the family; it is his right from the standpoint of profiting by an educational opportunity. This greatest of human events should be made as "complete an experience" as is possible at his stage of maturation. To let him have but a fragment and

that tinged with discomfort and a withdrawal of accustomed show of affection is to confuse him and injure his personality.

Jealousies between children over sharing possessions and parental attention can be overcome by scrupulous fairness on the part of adults and by the persistent effort to lead children into impersonal attitudes. When the solution is checked up to the children themselves, the parent presenting the evidence



Fig. 146.—A homemade Victrola stand. The toddler operates this and manages the records without assistance.

and acting in a strictly impartial judicial capacity, children can settle situations for themselves much earlier and much oftener than we commonly realize.

Rage, Anger, Temper.—The primitive emotion of rage or anger has been discussed on pages 502, 505. Like fear, anger may be said to rise out of the undifferentiated emotional matrix through the stimulus of thwarting situations. The stimulating situation in the case of fear is the near approach of pain, discomfort, or danger to one's self or to a dear one, or the imminence

of danger to cherished possessions, etc. The subject feels thwarted or unable adequately to meet or prevent the threatened injury.

The stimulating situation in the case of anger or resentment is one which prevents or thwarts the realization of an immediate goal. Fear may pass over into anger when escape becomes impossible, escape being the immediate goal sought.

The child who has been burned is terrified and runs away if threatened with a hot poker; while a child who wants very much to play with matches and set fire to a pile of leaves is angry and resistant if the matches are taken away from him. The child who is chased by another child with a hot poker may be both afraid and angry. He is afraid of the threatened pain and furious because his goal of safety and comfort is thwarted.

Rage, anger, and temper tend to be aggressive emotions and are more common to the extroverted than to the introverted type of child. The extrovert expression takes the form of attack and resistance; while in the introverted child anger may take the form of smothered resentment, sulkiness, or brooding.

Thwarting which provokes anger may take the form of restraint of freedom, as when an infant's hands or feet are held, or a toddler is dragged into the house by an adult; or the thwarting of one's right of possession, as when one child takes a toy belonging to another. One's code of justice or mores may be thwarted, as when an older child brings daddy's slippers when this rite has belonged to the toddler. The thwarting or injury may be to one's personality, as when some one jeers at Mary's red hair, or Eddie's modest family car.

The reaction, like all physical reactions, is protective or corrective. The small child struggles and screams. There are marked organic adjustments to the situation (as described in chap. VII under The Adrenal Medulla). Under the stimulus of "emergency energy" the child is literally forced into activity. This energy must have release. The more drastic the child's sense of thwarting or injustice the more intense is the energy charge in the nervous system. To struggle with a child who is stimulated by a surplus of adrenin in his blood stream is to add fuel to the fire. He is physically (chemically) unable to relax or come out of his anger-tension until this energy charge has spent itself. When

both parent and child are suffering from "adrenin intoxication" conflict may continue until the child is exhausted and often the parent has committed excesses in punishment which appall him when he "comes to himself" and views his conduct in retrospect.

The more helpless the child the fewer avenues he has for expenditure of his emergency energy and the more likely he is merely to have a tantrum of screaming accompanied by slashing, pounding movements of the whole body. Such children in a paroxysm of helplessness and fury will beat their own heads against the wall or floor, tear clothing and break and throw manipulatable objects.

Children who are continually subjected to thwarting which provokes anger reactions may become subject to tantrums and negativism and establish habits which may distort the personality permanently.

Revenge.—Extreme anger reaction takes the form of revenge or retaliation which may be immediate and overt or repressed and delayed. The introverted, repressed child, in particular, may quietly plan retaliation for injury which he easily rationalizes as justice. If Johnny breaks his wagon it appears to him only fair for him to watch his chance and, without danger to himself, "get even" by breaking Johnny's train of cars.

Many criminal acts of adults doubtless arise from early conditioning of this type. The personality may become so distorted by the habitual emotion of resentment that one may feel that all society is against him. He is negativistic and forever on the defensive. The child who is teased, "picked on," and tormented because he is sensitive or peculiar is at an insuperable disadvantage in his family or in society.

Doctor Florence Goodenough in a published study of anger in young children reports that overt manifestations of anger appear to reach a maximum during the second year and that as age advances the anger reaction changes from explosions of violent, undirected energy to relatively purposeful behavior. After-reactions such as sulkiness and resentment increase with age.

Doctor Goodenough discovered that overt reactions were of short duration. Among 1,878 outbursts, fewer than one-third lasted as long as 5 minutes.

Another significant observation was that children suffering from colds, constipation, or other deviations from health showed increased anger reaction.

There was also positive correlation between the incidence of previous illness and frequency of anger reactions. Children were most prone to anger shortly before meals. Also, the greater the number of adults in the family the more easily the child showed anger.

Dr. Goodenough concludes with the following suggestive remarks:

> A subjective judgment of the total home situation secured by a consecutive reading of all record for each child leads to the conclusion that the control of anger in children is best achieved when the child's behavior is viewed with serenity and tolerance, when the standards set are within the child's ability to achieve, and when these standards are adhered to with sufficient consistency to permit the child to learn through uniformity of experience, without such mechanical adherence to routine that the child's emotional or physical well-being is sacrificed to the demands of an inflexible schedule. However, when departures from the established schedule are made, they should be determined by a recognition of the needs of the child and not simply by the convenience or mood of the adult in charge. Self-control in the parents is, after all, likely to be the best guarantee of self-control in the child.[1]

Cruelty.—Young children, because of imperfect coordination and lack of experience, handle animal pets just as they handle animal toys and dolls. Sometimes a sturdy child inflicts pain and actually tortures a defenceless kitten. Dogs and cats, however, will endure surprising maltreatment from young children. With the rise of awareness of others the child should learn to avoid inflicting pain, and he will if his environment is normal. He requires time, however, in which to become aware of the difference between pulling the petals from a flower and pulling the wings from a butterfly. He must, especially, live among people who are kind to each other and to animals, and who do not permit the child to inflict pain upon living things.

Destructiveness, like other antisocial behavior, is much more easily prevented than cured. Two reasons predominate in

[1] Goodenough, Florence L., *Anger in Young Children*, pp. 248–249, University of Minnesota Press, 1931.



One hour old.



Four days old.



Eleven days old.



One month thirteen days old.



One month eighteen days old.



Two months old.

FIG. 147.—Kenneth at successive ages.

creating destructiveness in the normal child. First, the character and care of his play material. Flimsy, commercial toys literally "fall to pieces." They are made to last only until the sale is consummated. In the household in which this type of play



Two months one week old.



Three months one week old.



One year old.



Two years old.

FIG. 147, Cont.—Kenneth at successive ages.

material is permitted to predominate there is usually no thought given to the orderly care of the child's possessions, and he cannot acquire configurations and action patterns for respect and care of play materials. The other reason, especially with older

toddlers, is the lack of interesting occupation. As the child's curiosity and activity increase it becomes much more interesting to take things to pieces than merely to look at them and handle them quietly. Playthings should be made to be taken apart. The greed to "see the wheels go round" is a hunger as gripping and as essential as that for food or air.

As with other undesirable behavior, nothing is gained by scolding and punishment. New and proper configurations must be created by providing motivation and outlet, and, as always, the child must be given *time* in which to make adjustments.

Disobedience.—Under the theory of development and behavior adopted in this text there is no place for the term obedience in any sense other than its accepted use in the world of adult relationships. The child should, from the hour of his birth, learn to conform to situations and to respect authority. The child who has not developed protective reactions through unwise management *tends* to be cooperative. He will incline to respond to the requests and desires of others when these do not run too violently counter to his active interests and desires. When he must conform against his will quiet inflexibility will eventually bring acceptance of mealtime, bedtime, and all necessary conditions. The commonest mistake which parents make is in permitting an attitude of resentment and even anger to develop within themselves. The parent who knows and remembers that the child is reacting in the only way in which he can react at his particular maturation level and to the particular situation, and who can preserve an impersonal attitude and not treat the child as if he had committed a personal offense toward the parent is the parent who will have the best control of the child and who will help him most effectively eventually to gain control of himself.

It cannot be too frequently reiterated that all relationships with the child should be friendly, impersonal, and free from violent emotional content of any sort. The adult who can remain friendly with a child who is doing violence to the adult code and making trouble for that adult is the person who will have a constructive influence upon the character development of the child and will really affect his conduct favorably. The natural and inevitable reaction of a child to anger and blame in an adult

is withdrawal from the fault finder. It is true the child may acquire a protective avoidance of the act which provoked the displeasure and punishment, *but the reason is bound up with the disciplining person,* and it will be more difficult for him to acquire a correct perspective and understanding of the situation because the adult has introduced the distorting element of personal pain and fear.

Discipline and Punishment.—Punishment in the sense of inflicting painful consequences unrelated to the act has no place in an organismic philosophy of development and training. There is no use in beating a vine for growing across a window *we* desire to have clear. There is no use in bruising the flesh of a child because his growth urges have impelled him to do something contrary to adult convenience.

One may train a bush or a child to grow in artificial form, but it is better artistry only to assist both to achieve their respective patterns in full and complete measure.

It is not necessary to inflict pain upon a child in order to lead him to conform to his environment. *His maturation drives take care of this.* For example, his urge to share in household activities is the expression of his active adaptation to environment. This urge presents to the mother a golden opportunity to help him establish attitudes and habits of adaptation. If she does not understand this and punishes him for getting in her way and possibly dropping a dish he is placing upon a table, conflict and misunderstanding and resentment are needlessly engendered.

Punishment is a word which should be dropped from civilized human language, certainly from the vocabulary of child development. Discipline or "direction" hath a somewhat better sound if used in a proper sense. The child meets discipline in the sense of adaptation to reality, from the hour of his birth, when he must conform to an inflexible feeding schedule. Adaptation to reality means "complete experience" and constant assistance in forming accurate and logical "configurations" of cause and effect. It is a question whether disciplinary measures which are not causally related to the act produce any constructive effect.[1]

[1] MILLER, MARION M., *Our Children,* chap. XI, Discipline—Old and New, Viking Press, Inc., 1932.

It is a question whether the mother who spats hands while she says "no, no," to the inquiring child has made her bric-a-brac safer than has the mother who holds the object and lets the child examine it, then says "mother hold it, baby, no, no." The former mother is apt to think she has succeeded because the child *eventually* stops meddling. The child of the second mother stops meddling just as soon or sooner, and her child knows something about the qualities and handling of bric-a-brac which the first child does not. The first mother does not know that her child simply grew or matured beyond the meddling phase. Still less does she realize that the outstanding effect of her discipline has probably been to cause her child to seek satisfaction of his interests *when she is not looking.*

The policy of complete experience (configuration psychology) involves helping the child to see and even experience in some measure all the consequences of every act. If he goes upstairs he must come down. If he climbs a ladder which has been left against the garage, the mother, no matter how much fortitude it takes, should quietly stand by and encourage and, if need be, insist that the child come down entirely by himself. The child should not be made nervous or frightened, and the mother should stand where she might catch him if he were to fall, but she should not say "Don't be afraid, I'll catch you" (unless to a very small child). He should realize fully the difficulty and something of the danger involved in the act. This is more effective in preventing repetition than spanking or scolding.

A two-year-old, finding the ice-box door open and a number of round red tomatoes lying on a shelf, had a joyful moment throwing these right and left. The mother felt like scolding, possibly like spanking. Fortunately she was fair-minded enough to consider that the child had simply done what he had learned to do with red balls—throw them, that she had betrayed him to temptation by leaving the door open, and also that, after all, there was little likelihood of repetition. In order to make the experience educational, however, she did ask him to help her put them back, explaining the difference between balls and tomatoes, that the ball was "his," while the tomatoes were "mother's," and that mother kept her tomatoes in the ice box. The experience was completed by reminding him that *when things were*

thrown somebody always had to pick them up—"Baby throw, baby pick up."

There is little danger of this child's repeating this particular act. Through organic "transfer of training"[1] he will possibly think in similar situations, "Does this belong to mother or to me?" Another thing that may occur, however, is that when the grocer delivers some tomatoes a few days later the mother may find the toddler industriously storing them away in the ice box even if he must climb on a chair to open the door.

The habit of cooperative response which is the highest type of obedience is established by observing several principles in management.

1. Be certain the child understands what is expected of him, and remember that his memory span is short, and that requests must be repeated.

2. Request rather than order; encourage the idea that he is doing the thing because he wants to do it, or at least of his own free will, rather than because he must.

3. Show quiet approval of cooperation, but of the act, rather than of the child. Say, "That was a great help to mother," or "You did that well," rather than "You were a good boy."

It should never be forgotten that the less the child thinks of himself as "good" or "bad" and the more he thinks of the meaning of situations, the better rounded will be his character development. He should learn to do things *because they should be done, and because it is interesting to do them*, rather than because doing them brings praise to him. The insistence should be upon the thing rather than upon the child. Emphasize *going to bed*, all boys go to bed, boys must go to bed, rather than *you must* (give up and) go to bed.

4. Insist only on essentials. Do not place yourself in the embarrassing situation of commanding a child to do something which is actually not important and discover that you must weaken discipline by permitting disobedience or enter upon a devastating conflict with the child, leaving him with a smarting sense of humiliation and injustice.

[1] WHIPPLE, GUY, in the *Twenty-seventh Yearbook of the Society for the Study of Education*, Public School Publishing Company, 1927. Quoted by permission of the society.

5. Take cooperation for granted. A firm expectation disarms resistance. The mother says, "Johnnie, I've told you six times to put away your overshoes. *Are you going to do it?*" Just then father comes in and says "John, put away your shoes!" and Johnnie has started for his shoes before his father has ceased speaking. It is very likely that Johnnie has been spanked by his mother oftener than by his father. He simply knows which one expects obedience.

In general, clearness, fairness, firmness, and friendliness will produce a cooperative, independent, responsive, and helpful child.

OTHER PROBLEMS

Change of Environment.—When young children are taken on journeys or visits, or moved to a new home, considerable attention should be given to the mental-hygiene aspect of the situation in the case of the toddler. First of all, the regularity of his life should be conserved at all hazards. His food and sleep routine cannot safely be disturbed.

Secondly, he must be protected against confusion and bewilderment and fatigue. Pains should be taken to provide him with favorite playthings, and adults must restrain themselves from impatience with the child because of their own fatigue. His questions should be answered and the transition should be made as quietly and as naturally as possible.

Parental Disagreement.—Nothing is more utterly confusing and detrimental to character development than antagonistic disagreement between parents about anything, but especially about the management of the child. Every parental pair should have a hard and fast agreement before the child is born—or, better, before marriage—that they will never quarrel in the hearing of their children, and that, when they do disagree on certain points regarding the management of the child (and what two people *do* agree on everything!) they will thresh it out in private and, if unable to effect a compromise, that they will accept the decision of some authoritative arbitrator whom both parents respect.

Disagreement about food and feeding should *never* be mentioned at mealtime. There should not be arguments at bedtime, as often happens when one parent believes in the importance of

regular sleep and the other one intercedes for the child who does not want to go to bed.

The most devastating thing is where one parent believes in "instantaneous obedience" and "spare the rod and spoil the child" while the other one is trying to employ developmental methods.

Unavoidable Shock.—When a young child is exposed to the sight or experience of violence in the form of accident or catastrophe such as a fire, automobile accident, or personal injury, the mental shock may be serious and lasting. Every effort should be made to obliterate the memory. He should not hear the matter discussed. The excitement of adults communicates itself very directly to the child. His questions should be answered but in the least terrifying terms possible and with a calm nonchalant manner. As soon as possible, transfer the child's interest to some absorbing activity. Especially see that the child goes to bed and to sleep with pleasant images in his mind.

If the experience has conditioned fear in relation to trains, automobiles, or other commonplace objects, reconditioning will need to be skillfully done. The original impression should have faded as much as possible before the child is brought in contact with the source of fright. The first contact should be strongly associated with something pleasant. The child must not be forced into a situation which terrifies him—such as getting on an elevator if he is afraid of falling, or into a car after an accident. The child's cooperation must be secured, but it is easy to perpetuate an antagonism by too much coaxing and insistence.

Death.—When a familiar associate dies, or a pet dies, the necessity arises of trying to explain death to the child without creating shock and grief. In the case of death in the family great control should be exercised and the young child should be spared contact with the evidences of violent grief on the part of elders.

Sleep is about the only word possible to use with a child in explaining death, but this must be done guardedly. One child was made afraid to go to sleep himself after such an explanation.

Fortunately the customary drama and pageantry of the funeral ceremony soften the impression and color memory for the child.

Also, normally, children, owing to their primitive physical and social maturation and short memory span, bear separation from familiars very well. Few normal children grieve over the absence even of the mother, providing they are made comfortable and their established regimen is not disturbed.

With children who do not yet talk, quiet disappearance of the dead kitty or bird, with a casual attitude and substitution of new interests is the best method. From the questioning age on, frank explanation with dramatic burial ceremonies will meet the situation when a pet dies; and such a child may be taken to a family funeral if it can be managed casually and the music, flowers, and beauty of the occasion are emphasized.

Whatever is told the child should be in his own vocabulary and within his comprehension.

Left-handedness.—So much uncertainty exists at the present time as to the cause and results of left-handedness in children that it would seem to be the part of wisdom to let the left-handed child alone at least until there is evidence of more complete agreement among psychologists as to proper method of training. The child who is harassed and constantly disturbed in his thinking and activity by being urged to "use the other hand" is subjected to nervous strain and irritation. There is evidence that this may even cause nervous tics (jerking of certain muscles of face or body) and stammering and stuttering. It is true that some naturally left-handed persons do establish the use of the right hand without obvious injury. The proper method of doing this and the means of preventing undesirable effects are uncertain at the present time.

Adoption.—Every suitable "childless home" should absorb, not one, but several "homeless children." Foster children should be obtained from a first-class child-placing agency which is scrupulous and discriminating in the matters of investigating the heredity and health of the adopted child and in the selection of a home for the individual child. The matter of explaining the situation to the foster child is a perplexing one. No child should grow up in ignorance of the fact that he is an adopted child.

One family of the author's acquaintance told their first adopted child a here-and-now story of how they "wanted David," how they "hunted for David," and went to look at this baby and that

baby who "was not David," and finally, how they "got clothes ready, and toys ready, and a tub ready, and a basket ready—and took the basket and went to a big town and—FOUND DAVID! and brought him home in the basket to be their little boy." The child never tired of the repetition of the story, and asked a question now and then, as he grew older, until he quite understood the situation. Questions, especially questions the full answer of which would go beyond the child's understanding and experience, should be answered very simply and the explanation should *not* go beyond the child's maturation level.

In the instance given, the adoption of a second baby was a glorious event to David, equal in glamor and thrill to the arrival of any "really, truly" sister.

In general any normal or necessary experience can be made satisfying to the judgment and reason of the child. His personality should be protected from grief, bewilderment, and shock without giving him untrue or distorted concepts.

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CHAPTER XXXVII

OBSERVATION OF YOUNG CHILDREN

In order to apply the foregoing chapters to the understanding of individual children it is necessary to develop a technique of observation. The untrained person, gazing at an infant, sees merely a wriggling, helpless mass; it is only later that he is able to distinguish motor, language, adaptive, and personal-social items in the infant's behavior.

Since both students of child development and parents desire to see the significance of such behavior as has been discussed in the foregoing chapters, some suggestions will now be given as to how to proceed in making a developmental study of an individual child.

History

I. **The Home.**—Draw a plan of the grounds and house, indicating the relative size of yard and house, the floor plan of the house; marking the portions of each which the child uses, *i.e.*, where he plays, sleeps, etc. Mark directions N.S.E.W., also porches, garage, trees, shrubbery, etc. Draw detailed plans of play spaces inside and out, showing equipment and arrangement. Note arrangements for self-help at toilet, with wraps, playthings, etc.

II. **The Family.**—Personnel; age and sex of children; occupation of parents; circumstances determining time spent with child or children by adult members, etc. Any items of interest relating to or explaining the child's situation in the home, such as invalidism of any member; presence of roomers; guests; domestic help, etc.

III. **The Child.**—Name; date of observer's first visit; child's birth date; present age in months and weeks.

1. *Physical Data.*—Prenatal history: health, diet, exercise of mother during pregnancy; birth history. Postnatal history: size at birth; present height and weight; average weight for present age and height (see p. 639). History of feeding, sleep, elimination (including early training); illness and operations. Medical supervision: well-baby clinic or visits to pediatrician.
2. *Development.*—Teething history; date when child sat, crept, stood, walked, climbed; said first word, first sentence; number of words at present.

3. *Behavior.*—What *regular habits* and when established; bowel movement, urination, feeding, sleeping, outdoor life, etc. *Emotional habits:* crying, tantrums, sucking thumb, fears, negativisms, jealousy, whining, fretting, etc. Cooperation, cheerfulness, affection (how expressed), etc. The Merrill-Palmer Rating Chart, page 633, will be helpful in this.

Observation of Child

I. Description of physical appearance, attitude toward visitor, behavior during visits, etc. The observer should have at all times a quiet, impersonal attitude and permit the child to make the advances. Avoid making the child aware that he is the object of the visit; strive to have him feel natural and at ease and unconscious of attention, and entirely unconscious that he is being talked about. The observer may quietly fall in with what the child is doing and thus establish a rapport which will permit her to apply the normative tests in a happy, natural manner.

II. Apply normative tests as designated on page 639 and also compare the behavior of the child with the text discussion of his age period. Apply the normative tests, as occasion offers, as far as the child can go with each.

III. Record everything seen on occasion of each visit in simple narrative form with subsequent analytical discussion as indicated.

IV. Observe personality reactions and rate as traits are observed according to the Merrill-Palmer rating chart, page 633.

V. Observe language. If the subject is a young child who does not yet form sentences, try to record sounds and syllables and compare with the various studies of early vocalization. If child can converse talk with him as occasion offers and develop the points listed on page 635.

VI. Activity. Describe the activity and play of child at each visit; what he plays with and how. Does he do the expected thing according to "the books"?

VII. Parental attitude. Rate according to "Parental Attitudes," page 636, as evidence of habitual attitudes appears.

VIII. Summarize.

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Personality Rating Chart for Preschool Children[1]

Directions for Rating:

Mark each of these items either + or − according to your judgment of whether it describes the child or not. Do not be troubled by inconsistencies if you have faithfully marked those characteristics which you think predominate. Do not omit any item. It will be impossible to score your results if you do.

Effective Energy

( )(+) Skillful in body control; good coordination.
( )(−) Weak and frail.
( )(+) Vigorous and energetic in his attack on a project.
( )(+) Sturdy, strong, robust.
( )(−) Awkward in bodily movements, poor coordination.
( )(−) Attacks work with little vigor; gentle.
( )(+) Independent (considering age); self-reliant.
( )(−) Slow, without force, spiritless.
( )(−) Voice lacking in animation; lifeless.
( )(+) Adventurous; challenged by the untried.
( )(+) Participates in activity.
( )(−) Dependent; asks help of others.
( )(+) Physically vigorous; alert; energetic.
( )(−) Becomes fatigued easily.
( )(−) Usually stands around watching others, doing nothing himself.
( )(−) Fails to complete a task if obstacles arise.
( )(−) Overcautious, not venturesome, afraid to attempt the untried.
( )(+) Nearly always accomplishes task in spite of difficulties.
( )(+) Voice animated, alive.
( )(+) Does not become fatigued easily.

Mental Effectiveness

( )(+) Alert and responsive to environment.
( )(−) Poor in concentration.
( )(−) Merely copies other children's reactions, not original.
( )(+) Memory (for songs, games, etc.) above average or unusual.
( )(−) Slow to observe changes in surroundings.
( )(+) Concentrates well at his task.
( )(−) Memory (for games, songs, etc.) below average or poor.
( )(+) Original and inventive reactions.
( )(−) Attacks each situation with trial and error method.
( )(+) Imaginative.
( )(−) Quick to sense changes.

[1] From *The Merrill-Palmer Standards of Physical and Mental Growth*, by Wilson, Sweeny, Stutsman, Chesire, and Hatt, chap. II, pp. 19–20, Fig. 4, the Merrill-Palmer School.

( )(−) At loss to solve own difficult situations.
( )(−) Unimaginative.
( )(+) Curious or questioning.
( )(−) Mentally sluggish and unresponsive to environment.
( )(+) Makes use of past experiences in dealing with new situations.
( )(+) Expresses himself well for his age.
( )(+) Resourceful in solving own situation.
( )(−) Incurious, unquestioning.
( )(−) Poor use of language for his age.

Emotional Control

( )(+) Patient.
( )(+) Mature in emotional reactions (considering age).
( )(+) Absorbed; self-sufficient in his activity.
( )(+) Not self-conscious.
( )(−) Impatient.
( )(−) Infantile in emotional reactions (considering age).
( )(+) When request is made of him, complies with it.
( )(+) Somewhat irritated at failure but quickly gets over it.
( )(−) Restless—a certain dissatisfaction with his own activity.
( )(−) Self-conscious.
( )(−) Retiring; wishes to be in the background; repressed; restrained.
( )(+) Even-tempered.
( )(−) Aggressively attempts to be the center of attention.
( )(−) Strikingly irritated if not successful in accomplishing the desired objective.
( )(+) Spontaneous; assertive; asks for what he wants.
( )(−) Frequently disturbed; easily upset by the disagreeable or exciting.
( )(−) Excitable; high-strung.
( )(+) Makes a normal bid for attention, affection, and power.
( )(−) When request is made of him, tries to evade or distract the one making request.
( )(+) Seldom disturbed; sudden changes in mood infrequent.

Ease of Social Adjustment

( )(+) Enjoys participating in group activity.
( )(+) Doesn't seek attention.
( )(−) Slow to adjust to a novel experience.
( )(−) Unpopular with associates.
( )(−) Seeks attention.
( )(+) Readily adjusts to a new social situation.
( )(−) Not dependable, unreliable.
( )(+) Popular with children.
( )(−) Doesn't defend his own rights.
( )(+) Leads children of his own age and older.
( )(+) Kind to his playmates.

( )(+) Plays with other children.
( )(+) Dependable, responsible, trustworthy.
( )(−) Reacts against authority.
( )(+) Defends his own rights.
( )(−) Unkind to his playmates.
( )(+) Adjusts to authority.
( )(−) Plays alone.
( )(−) Doesn't enjoy group participation.
( )(−) Follows children his own age and older.

Skill in Work and Play

( )(+) Handles play material skillfully.
( )(−) Destructive, finds satisfaction in tearing down work.
( )(−) Lazy.
( )(+) Uses time effectively.
( )(+) Tidy; careful in use of equipment.
( )(+) Purposeful.
( )(+) Original in play.
( )(−) Uses time ineffectively.
( )(+) Industrious.
( )(+) Constructive; finds satisfaction in putting things together.
( )(−) Not original in play.
( )(−) Aimless in activity.
( )(−) Careless in use of material.
( )(+) Persistent until task is accomplished.
( )(+) Concentrates on work to be done.
( )(+) Chooses many types of material in play.
( )(−) Is easily distracted from task at hand.
( )(−) Gives up easily, lacks persistence.
( )(−) Shows limited range in choice of play materials.
( )(−) Awkward in manipulation of equipment.

Conversation with Child

Questions to be asked as opportunity offers in casual, natural conversation with child. In general, let the child lead and avoid making him feel conscious of being "quizzed." Ask these or equivalent questions and record as accurately as possible the exact words of the child's answers. Classify all words as parts of speech. Note accuracy and clearness of pronunciation. Note sentence construction. Record as nearly as possible all of the child's conversation.

1. *Sensory Discrimination.*—What color is this (point to each of the primary colors)? Which is heavier (present two objects of unequal weight)? Which is bigger (present a large and a small doll)? With a small child who cannot draw comparisons say is this big? Is this little? etc. Is this cold? Is this warm? (presenting cups of cold and warm water). Do the same for rough, smooth; hard, soft; bright, dull, etc.

2. *Sense of Number and Time.*—How many pennies are in my hand? (Show 2–3–4 as far as child can go). Have you had breakfast, lunch, dinner? When do we eat breakfast, lunch, dinner? Where do we go on Sunday, etc.? When do we go to bed; get up?

3. *Orientation.*—Where do you sleep, eat, take a bath, etc.? Where is the kitchen, etc.? Where do you play outside the house? Do you have a garden? What grew in the garden last summer? Who lives next to you (point to both sides and go as far on street as child knows neighbors)? Where do you get bread, meat, candy, milk? Do you ever go down town? Where is "down town"? How did you go down town? What did you see down town?

Where is the store? What do you get at the store? Who keeps the store?

Where is_____? (any town the child has recently visited). How did you go to_____? Who lives at_____, or whom did you see? What did you do, etc.?

Where is daddy? Where does he work? What does he do? Where does grandmother live? Where is brother, etc.?

4. *Imagination and Imitation.*—Play peek-a-boo, pat-a-cake, etc., according to age of child. Where is Santa Claus? What did Santa Claus bring you? Let's play having a tea party. Isn't this good cake, etc.?

Tell me the story about the Three Bears, etc.

What does the dog, rooster, cat, etc., say?

Does your dolly eat? What does she like to eat, etc.?

5. *Causality.*—What makes the house warm? Who makes the fire? What does he burn to make the fire in the furnace?

What happens if you touch the fire? What did mother do when you burned your finger (if he remembers such an experience)?

What do you like to eat? Why does mother cook meat, bread, etc.? Any questions as to why things are so?

6. *Appreciation of Beauty.*—Questions as to music, pictures, pretty clothes, etc., designed to elicit statements as to what the child especially likes or admires and (if old enough) why?

Parental Attitudes

In observing the attitude of the adults in any family toward the child who is being studied, the following descriptive items may be suggestive.

I. *Discipline.*—To what extent is the child helped to experience the logical results of conduct?

Is painful punishment inflicted; if so how and how often?

To what extent is putting to bed or other form of isolation used?

To what extent is deprivation of privilege used?

To what extent is scolding, threatening, or nagging employed?

To what extent is reasoning used, and with what success?

Do parents have a consistent policy as to discipline? Do they agree? Does the child know what to expect?

To what extent is "obedience" exacted?

Does either parent exploit the child's affection as a method of control, *i.e.*, "You'll make mother cry"?

Is punishment prompt or delayed?

Does the father punish for occurrences during his absence?

II. *Management of Special Problems.*—How do the parents manage special situations such as the following?

1. Questions relating to sex and reproduction.
2. Untruthful statements: (*a*) imaginative, (*b*) to escape punishment, (*c*) to gain attention.
3. Thumb sucking; nail biting; bed wetting; and other physical problems.
4. Temper tantrums, anger, negativism.
5. Irritability, peevishness, crying, whining.
6. Quarreling or fighting with other children.
7. Running away.
8. Disobedience.
9. Refusal of food.
10. Refusal to go to bed.
11. Cruelty to pets or to children.
12. Destructiveness.

III. *Participation in Play Life.*—How much time does each parent give to participation in play of child: (*a*) active play, (*b*) reading and story telling, (*c*) excursions, (*d*) building or making equipment, (*e*) singing, drawing, nature study, (*f*) make-believe play, dramatization, etc.

IV. *Study of Child Development and Training.*—To what extent does each parent read child-development literature, participate in group study? What is extent of previous study and training?

Summarize All Findings.—When the biographical history is written, together with an account of the various tests described, and all other significant or interesting items of behavior that occur spontaneously during observation have been added, a consistent picture of the development and temperament of the child should appear. This is valuable as training for the student in the technique of observation. The results are not to be taken too seriously as an untrained observer makes many errors. The student, however, should be better able to see unity in every child's physical and mental development and behavior, after having made a comprehensive and orderly study of one child.

Weight-height-age Table for Girls from Birth to School Age[1]

Height, inches	1 mo.	3 mos.	6 mos.	9 mos.	12 mos.	18 mos.	24 mos.	30 mos.	36 mos.	48 mos.	60 mos.	72 mos.
20	8											
21	9	10										
22	10	11										
23	11	12	13									
24	12	13	14	14								
25	13	14	15	15								
26	..	15	16	17	17							
27	..	16	17	18	18							
28	..	..	19	19	19	20						
29	..	..	19	20	20	20						
30	..	..	21	21	21	21	21					
31	..	..	..	22	22	23	23	23				
32	..	..	..	..	23	24	24	24	25			
33	..	..	..	..	..	25	25	25	26			
34	..	..	..	..	..	26	26	26	27			
35	..	..	..	..	..	29	29	29	29	29		
36	..	..	..	..	..	..	30	30	30	30	31	
37	..	..	..	..	..	..	31	31	31	31	32	
38	..	..	..	..	..	..	..	33	33	33	33	
39	..	..	..	..	..	..	..	34	34	34	34	34
40	..	..	..	..	..	..	..	..	35	36	36	36
41	..	..	..	..	..	..	..	..	..	37	37	37
42	..	..	..	..	..	..	..	..	..	39	39	39
43	..	..	..	..	..	..	..	..	..	40	41	41
44	..	..	..	..	..	..	..	..	..	..	42	42
45	..	..	..	..	..	..	..	..	..	..	..	45
46	..	..	..	..	..	..	..	..	..	..	..	47
47	..	..	..	..	..	..	..	..	..	..	..	50
48	..	..	..	..	..	..	..	..	..	..	..	52

Weight-height-age Table for Boys from Birth to School Age[1]

Height, inches	1 mo.	3 mos.	6 mos.	9 mos.	12 mos.	18 mos.	24 mos.	30 mos.	36 mos.	48 mos.	60 mos.	72 mos.
20	8											
21	9	10										
22	10	11										
23	11	12	13									
24	12	13	14									
25	13	14	15	16								
26	..	15	17	17	18							
27	..	16	18	18	19							
28	..	..	19	19	20	20						
29	..	..	20	21	21	21						
30	..	..	22	22	22	22	22					
31	..	..	..	23	23	23	23	24				
32	..	..	..	24	24	24	25	25				
33	..	..	..	..	26	26	26	26	26			
34	..	..	..	..	..	27	27	27	27			
35	..	..	..	..	..	29	29	29	29	29		
36	..	..	..	..	..	..	30	31	31	31		
37	..	..	..	..	..	..	32	32	32	32	32	
38	..	..	..	..	..	..	..	33	33	33	34	
39	..	..	..	..	..	..	..	35	35	35	35	
40	..	..	..	..	..	..	..	..	36	36	36	36
41	..	..	..	..	..	..	..	..	..	38	38	38
42	..	..	..	..	..	..	..	..	..	39	39	39
43	..	..	..	..	..	..	..	..	..	41	41	41
44	..	..	..	..	..	..	..	..	..	..	43	43
45	..	..	..	..	..	..	..	..	..	..	45	45
46	..	..	..	..	..	..	..	..	..	..	..	48
47	..	..	..	..	..	..	..	..	..	..	..	50
48	..	..	..	..	..	..	..	..	..	..	..	52
49	..	..	..	..	..	..	..	..	..	..	..	55

[1] Prepared by Robert M. Woodbury, Ph. D., published by the U. S. Department of Labor, Children's Bureau.

Normative Summaries for First Five Years

(adapted from Gesell)

The items of the recording schedule are reproduced below as normative summaries for each of the developmental levels. These items have been given an age location; it is clear, however, that they cannot be scored on a purely plus and minus basis and arithmetically compounded into a psychometric mental age. It must be emphasized that serious use of the schedule, in its present form, presumes a large amount of clinical familiarity with infants of every age.

Age	Motor-development	Language	Adaptive behavior	Personal-social behavior
1 month.....	(*a*) Lifts head from time to time when held to the shoulder; (*b*) makes crawling movements when laid prone on flat surface; (*c*) lifts head intermittently, though unsteadily, when in this prone position; (*d*) turns head laterally when in prone position	(*a*) Gives definite heed to sound; (*b*) has differential cries for discomfort, pain, and hunger	(*a*) Stares at a window or at massive objects; (*b*) gives visual heed to conspicuous moving objects; (*c*) gives transient visual regard to the red ring; (*d*) retains definite hold of the ring when it is placed in the hand	(*a*) Makes tactually perceptible postural adjustments when taken up by the examiner; (*b*) shows selective regard for the face
2 months.....	(*a*) Holds head erect for a short time when held to the shoulder; (*b*) lifts head when suspended dorsally (the head being momentarily unsupported to test the compensatory postural adjustment); (*c*) lifts the chest a short distance above the table surface when in the prone position; (*d*) makes vertical arm thrusts in random play when in the dorsal position	(*a*) Attends readily to the speaking voice; (*b*) makes a facial response to a social approach (in which the examiner brings face near the child to attract attention); (*c*) makes several different vocalizations	(*a*) Eyes follow moving person; (*b*) gives prolonged regard to dangling red ring	(*a*) Head turns or fixates in response to speaking voice; (*b*) makes definite motor adjustment, in shoulder region, to being lifted; (*c*) kicks feet in bath or reacts with pushing leg movements

3 months.....	(*a*) Holds head erect and steady when held to shoulder; (*b*) rotates body from dorsal to side position; (*c*) pushes or elevates self by arms in prone position	(*a*) Smiles responsively to social approach; (*b*) gives vocal expression to feelings of pleasure	(*a*) Eyes follow moving pencil; (*b*) head turns freely in inspection; (*c*) varied tactile manipulation of ring; (*d*) varied inspection of environment (when in dorsal position)	(*a*) Startles or betrays awareness when suddenly changed to a strange situation; (*b*) quieted by voice or music; (*c*) shows anticipatory excitement, or opens mouth expectantly in feeding; (*d*) fingers one hand with the other in tactile motor play
4 months.....	(*a*) Holds head steady when carried or when swayed; (*b*) lifts head and shoulders in dorsal position as an effort toward sitting; (*c*) sits with resistant body posture when supported by pillows; (*d*) hands no longer predominantly clenched, but frequently open	(*a*) Laughs aloud; (*b*) vocalizes in self-initiated sound play; (*c*) responds vocally when socially stimulated	(*a*) Closes in with both hands on dangling ring, when in dorsal position; (*b*) manipulates table edge when held in lap; (*c*) regards one-inch cube on table; (*d*) turns head in pursuing slowly vanishing object	(*a*) Inspects own hand in play; (*b*) plays in simple manner with rattle; (*c*) splashes with hand in bath; (*d*) makes definite anticipatory adjustment to being lifted
5 months.....	(*a*) Rolls from back to stomach; (*b*) sits with slight prop; (*c*) picks up cube from table on contact	(*a*) Turns head to voice or to hand bell; (*b*) gives vocal expression of eagerness; (*c*) vocalizes displeasure on withdrawal of coveted object	(*a*) In dorsal position recovers rattle which has fallen within easy reach; (*b*) makes reaching approach to piece of paper favorably presented; (*c*) eyes cooperate in prehension and manipulation	(*a*) Plays actively with rattle with recurring visual regard; (*b*) exploits bath playfully
6 months.....	(*a*) Sits momentarily without support, if placed in a favorable leaning position; (*b*) grasps with simultaneous flexion of fingers; (*c*) retains transient hold of two cubes, one in either hand	(*a*) Vocalizes several well-defined syllables; (*b*) expresses recognition of familiars; (*c*) actively vocalizes pleasure with crow or cooing	(*a*) Reaches for object on sight; (*b*) picks up cube from table on visual cue; (*c*) regards pellet placed on table surface	(*a*) Bangs spoon or pats table in play; (*b*) discriminates between strangers and familiars

NORMATIVE SUMMARIES FOR FIRST FIVE YEARS—(*Continued*)

Age	Motor-development	Language	Adaptive behavior	Personal-social behavior
7 months.....	(*a*) Tends to unilateral reaching and manipulation; (*b*) rotates wrist freely in manipulation; (*c*) secures pellet with raking or scooping palmar prehension; (*d*) picks cube deftly and directly from table	(*a*) Vocalizes satisfaction in attaining object	(*a*) Reaches persistently for remote cube; (*b*) lifts inverted cup; (*c*) manipulates ring with sustained inspection; (*d*) gives transient heed to fallen spoon	(*a*) Plays exploitively with paper; (*b*) plays exploitively with string; (*c*) reacts to mirror image by manipulation or approach
8 months.....	(*a*) Sits momentarily without support; (*b*) raises self to sitting position; (*c*) picks up pellet with partial finger prehension	(*a*) Gives vocal expression to recognition; (*b*) vocalizes in interjectional manner	(*a*) Definitely looks for fallen spoon; (*b*) utilizes handle in lifting inverted cup; (*c*) shows manipulatory interest in details of bell	(*a*) Shows definite responsiveness to frolic play; (*b*) pats or smiles at mirror image; (*c*) restores bottle to mouth; (*d*) shows interest in throwing and sound production play
9 months.....	(*a*) Sits alone; (*b*) opposes thumb in seizing cube; (*c*) makes a locomotive reaction in prone position	(*a*) Says Da-da or equivalent; (*b*) listens with selective interest to familiar words	(*a*) Brings inset block and form board into exploiting relation; (*b*) uses string and pulls ring; (*c*) gives definite attention to scribbling demonstration	(*a*) Cooperates in rhythmic nursery games; (*b*) waves bye-bye or performs similar trick; (*c*) plays combiningly with cup and cube
10 months.....	(*a*) Pulls self up to standing position (*b*) plucks pellet with precise pincer prehension	(*a*) Incipient or rudimentary imitation of sounds; (*b*) makes conditioned adjustment to certain words	(*a*) Accepts third cube or retains two cubes; (*b*) makes incipient, induced imitation of scribble; (*c*) explores formboard holes manually; (*d*) lifts cup by handle and secures concealed cube	(*a*) Makes playful response to mirror image; (*b*) dangles ring by string in play
12 months.....	Walks with help; lowers self from standing to sitting position; holds crayon adaptively to make stroke	Says two "words"; adjusts to simple verbal commissions; places cube in or over cup on command	Imitates scribble or rotary spoon rattle; adjusts round block to form board or rod to hole; uses string adaptively to pull ring; secures cube wrapped in paper	Holds cup to drink from; inhibits simple acts on command; repeats performance laughed at

15 months.....	Stands alone; walks alone	Says four words; uses expressive jargon	Secures third cube; builds tower of two blocks; makes discriminative reversed adaptation of round block to form board	Uses spoon; cooperates in dressing; bowel and bladder control regularized
18 months.....	Climbs stairs or chair; throws ball into box; scribbles spontaneously and vigorously	Says five or more words; uses jargon conversationally; points to nose, eyes, or hair	Builds tower of three or more blocks; makes an imitative stroke with crayon; places cube in cup or plate; accepts four or more cubes	Uses spoon with good control; fills cup with cubes in play; turns pages of book; looks at pictures
21 months.....	Walks attended on the street; walks backward; differentiates between stroking and circular scribble	Joins two words in speech; names one picture; repeats things said	Places square in form board; differentiates between tower and bridge; folds paper once on demonstration	Bowel control established; asks for things at table (or for toilet); pulls persons in order to show something of interest; tries to turn door knob
24 months.....	Runs; piles tower of six blocks with good coordination; imitates vertical or horizontal strokes	Names three of five objects; points to five objects on card; uses words in combination	Places blocks in row to make train; adapts to reversal of form-board; creases paper definitely in imitation; places cube in cup, plate, or box	Plays with mimicry; tells experiences; listens to words or phrases; explains pictures
30 months.....	Goes up- and downstairs alone; piles seven or eight blocks with coordination; tries to stand on one foot; copies vertical or horizontal line	Points to seven pictures; names five pictures	Attempts to build bridge from model; adapts to form board with corrected initial error; places one completion form; marks twice for cross	Gives full name; helps mother to put away things
36 months.....	Draws a circle from copy; draws a horizontal stroke imitatively; creases a piece of paper neatly; aligns a card to an edge	Uses pronouns, past tense, and plural; names three objects in a picture; can tell simple stories; distinguishes prepositions in, under, behind	Builds bridge imitatively; builds block tower of four or more; discriminates between two short lines; combines two parts of severed picture	Can open door; can carry breakable object; asks questions of elders; puts on shoes

NORMATIVE SUMMARIES FOR FIRST FIVE YEARS—(*Continued*)

Age	Motor-development	Language	Adaptive behavior	Personal-social behavior
48 months.....	Draws cross from copy; traces diamond path; hooks fish in fish-pond game in 15 or 30 seconds with right or left hand	Distinguishes four prepositions; uses descriptive word with picture; repeats twelve syllables	Folds paper diagonally; draws three completions in incomplete man; completes patience pictures; puts two blocks in cup	Uses building material constructively; buttons clothes; goes on errands outside of house; washes self
60 months.....	Draws triangle from copy; draws prism from copy; hooks fish three times in one minute	Defines words by use; knows three or more words in vocabulary list; interprets humor; speaks with noninfantile articulation	Builds keystone gate; completes four of eight forms; discriminates weights; performs three commissions	Draws recognizable man and tree; laces shoes; puts on coat and hat alone; uses play material with advanced constructiveness; replaces material in box neatly

APPENDIX A

BASAL METABOLISM

Graham Lusk defines metabolism as "the chemical changes of materials under the influence of living cells."[1] What initiates these chemical changes is unknown—it is the mystery of life. We simply know that life involves constant and perpetual chemical changes in its protoplasmic medium. This change or movement of molecules and atoms and colloids is called *energy*. As a molecule breaks down and builds up its structure ("changes") it releases this energy as mechanical energy, or electrical energy, and both are accompanied by *heat*. Since heat is a fixed and invariable accompaniment of metabolic changes, and since heat is measurable, it has become the practice to measure the chemical or metabolic activity or energy of a living organism in terms of its heat production and radiation.

Let us think of a living organism, a child's body, for example, as having an individual chemical "pattern" resembling in general the chemical patterns of all other children, but having also certain individual peculiarities of its own. Whence came this child's peculiar and personal chemical scheme we do not know, except that it seems to have been conveyed to him via his ancestral genes and chromosomes. However, here he is, with his aggregation of millions of chemical cell units, *each maintaining its own structural chemical integrity, and each contributing something to the organic integrity of the whole.* These chemical cell units of bone and muscle and gland and brain are dependent upon the environment of the child, in the forms of air and water and food and light, for the materials of maintenance of their pattern.

We have had a glimpse in the chapters on Food and Nutrition of the intricate ways in which the various "balances" (fixed chemical relationships) which go to make up the total pattern

[1] Lusk, Graham, *Science of Nutrition*, pp. 32–33, 4th ed., W. B. Saunders Company, 1928.

are achieved and maintained. A delicately adjusted living machine is maintaining itself in "running order," since it never stops or "shuts down" even in sleep, and it is also producing an infinite variety of specific accomplishments or activities.

It will be apparent on thought that a rather uniform and stabilized amount of chemical change is involved in *merely living*—in simply carrying on the vital processes of circulation, breathing, digestion, and elimination.

This is called *basal metabolism.* Starting from this as a "base" we recognize that a widely varied and variable expenditure of energy is involved in the active relationships of the organism with the larger aspects of his environment; walking about, talking, working, playing. This involves the provision of *stored energy* which is the *margin* determining and limiting what we do *more* than merely live.

This margin naturally depends, first of all, upon a normal basal metabolism, a chemically adequate machine. In the second place, it depends upon certain inherited and certain acquired potentialities in the way of fuel storage and chemical reactions. Also, of course, balanced and adequate food intake is necessary.

Basal metabolism is measured in terms of the heat created and expended by the organism when it is merely existing, or rather in the nearest approach to mere existence which it is practically possible to realize. Basal metabolism is taken with the subject completely at rest, usually in the morning after the night's fast of 12 to 14 hours. The very minimum of energy is expended during sleep—but it is not practicable to have subjects sleep under the conditions of routine clinical and laboratory tests, therefore a condition of waking relaxation is usually employed.

Basal metabolism is measured in terms of calories, a calorie representing the heat required to raise the temperature of one kilogram of water one degree centigrade. The food simply and literally is fuel which is burned in the body, slowly and insensibly to be sure, but with release of heat equivalent to that produced by oxidation of the same substance outside the body. The "100-calorie portion" of food means the amount of the stated food required to create 100 calories of heat when burned. "A piece of good coal weighing 0.6 ounce will, when burned, yield 100 calories. A potato weighing 5.3 ounces will create this much

heat. An apple weighing 0.4 ounce, 0.9 to 1.0 ounce of sugar, starch, dry cereal, or flour, 1.4 ounces of bread, about 10 ounces of carrot, or 24 ounces of lettuce will each produce 100 calories."[1]

A scientific engineer, knowing the heat concentration of his various types of fuel, can calculate with exactness as to the amount and kind of fuel he must provide to maintain a constant steam pressure or work output from his engine. In like manner it is now possible to compute the number of food calories which animal bodies of various sizes require to maintain the normal animal heat of the body, or carry on the vital processes, merely live, without drawing upon body storage or reserve.

The basal metabolism is determined by placing the individual, a certain number of hours after taking food, at rest in a calorimeter (heat meter). The type of calorimeter commonly used is an air-tight chamber so constructed that all heat given off by the body is measured and recorded. At the same time the fuel value of the excretions of the body; carbon dioxide, urine, feces, must be computed. All components of the situation are reduced to exact measurement.

Certain formulas have been developed whereby normal basal metabolism is readily determined. All bodies with a given surface area and of a stated age and in a condition of health consume fairly similar amounts of body fuel under controlled conditions of food, rest, and external temperature, and give off fixed amounts of heat in the calorimeter. The basal metabolism for the average man has been found to be approximately 39.7 calories per square meter of body surface per hour; the average for women is 36.9 calories.

Under the stimulus of too much thyroid secretion (hyperthyroidism) the body consumes too much fuel and the basal metabolism is raised. If the thyroid does not function sufficiently, through disease or lack of iodine (see page 109), the basal metabolism is lowered. This means that fuel reserve is being needlessly consumed if the basal metabolism is too high, or that not enough energy is being produced for normal living if it is low. In one case the damper is open, the heat goes up the chimney. In the other the furnace does not "draw."

[1] Willard and Gillett, *Dietetics for High Schools*, p. 16, The Macmillan Company, 1920.

Every disease or disorder involving the chemical metabolism of the body is apt to affect the basal metabolism. It is highly important that the actual metabolic rate be known as an item of the diagnosis and treatment of a good many disorders of health in both child and adult.

By knowing normal basal metabolism it has become possible to measure various types of energy demands. Even sitting, standing, or walking raises the fuel conbustion. Oxidation or combustion is enormously increased by strenuous muscular effort, such as running or hard work. Pregnancy raises the basal metabolism by adding the energy requirements of the body of the fetus to that of the mother. Lactation raises the basal metabolism. A nursing mother who also does muscular work will have need for a very large increase in food.

The fuel or food needed to maintain the basal or subsistence metabolism of a young adult is approximately one calorie per kilogram (2.2 pounds) of body weight per hour. In addition to this, merely the process of digestion of an ordinary mixed diet requires about a 10 per cent increase of energy.

The following table from *Foundations of Nutrition* (page 58) by Mary Swartz Rose will illustrate the fact that the food needs of the body are definite and measurable, and will make it quite

Energy Expenditure for Different Grades of Muscular Activity

Grade of activity	Calories per kilogram per hour	Calories per pound per hour
Lying at rest	1.00	0.48
Sitting at rest	1.43	0.65
Very light exercise	1.93	0.88
Light exercise	2.43	1.10
Moderate exercise	4.14	1.88
Severe exercise	6.43	2.92
Very severe exercise	8.57	3.90

clear that no mother should experiment with her diet, especially with the caloric allowance, of herself or her children. Any deviation from accepted dietary standards should be undertaken only under expert advice.

FOOD SELECTION AND ANALYSIS

In order to judge of the amount and content of the personal diet day by day it is necessary to have some simple and convenient scheme of estimate or measure. The "100 caloric portion" has proved to be a practical and satisfactory unit of measurement.

The following table of food values has been compiled chiefly from the texts of Mary Swartz Rose. They are designed to enable the expectant mother to make an approximate evaluation of her daily dietary as far as the most essential items of balance are concerned.

It is suggested that paper be ruled to correspond to the form here given, and that all food taken for one day be entered and distributed according to the values here assembled. The footing of each of the columns at the end of the day should give, when compared with the normal average at the head of the column, a rough estimate of the "balance" of the day's food intake.

The results of such an analysis are not to be taken too literally as, fortunately, it is not necessary that one be so precise in food selection, and it would greatly interfere with enjoyment and practical convenience if one pursued the matter too slavishly. Over a period of a week, however, there should be fair conformity to the proportions of the norm here given. *No marked deficiency should appear, and no marked disproportion between protein, fat, and carbohydrate.*

Deficiency is much more serious than oversupply of minerals and vitamins. Dr. Mendel, in his report to the Medical Section of the White House Conference, says, "Large latitude in the proportions of the nutrients is allowable *so long as the law of the minimum is not disregarded!*"

While the acid-base balance should be rather definitely on the side of the alkali-producing foods, there must be a fair proportion of acid-forming food, since bread, eggs, and meat fall in this class.

The distribution of values is on a basis of the 3,000-calorie diet accepted as the average for the last months of pregnancy. If the doctor has advised a total of 2,000 or 2,500 calories rather than 3,000, the reduction should be accomplished through cutting

down the carbohydrate and fat calories, *but not the protein or mineral totals*, unless so advised by the physician. The subject should select from the list provided foods, or similar foods, which will give approximately the required totals and the advised variety. *Especially should she avoid reducing the protein, calcium, phosphorus, and iron totals.*

As to the vitamins, the day's diet should show generous provision of A, B, and C. The sources of vitamin D in reliable, effective amounts are now considered to be limited chiefly to liver, cod-liver and other liver oils, viosterol, or other concentrate of vitamin D, and egg yolk. If whole grain and cereals are used frequently, together with the large amount of fresh and leafy foods so emphatically advised, there is no likelihood of a shortage of vitamin E. If the protein quotient is up to standard there will be no shortage of vitamin G, since it generally accompanies the common protein foods.

After one has made a careful analysis of a week's typical diet and adjusted it to meet her requirements, it is not necessary to continue this exacting procedure. She will have "a pattern in her mind," and will have only to make new analyses when, through seasonal or other causes, she introduces foods of whose specific value she is ignorant.

Table of Common Foods[1]

(Distribution of 100-calorie portions)

Food material	100-calorie portions in common measure	Protein weight, grams	Protein calories per 100-calorie portion	Carbohydrate calories per 100-calorie portion	Fat calories per 100-calorie portion	Grams per 100 calories			Vitamins			Excess of	
						Calcium	Phosphorus	Iron	A	B and G	C	Acid	Base
Total average daily requirement in late pregnancy	3,000	100+	300 to 450	1,800	750 to 900	1.40	1.59	0.0174					
Almonds	10–12	3.24	12	10	78	0.037	0.072	0.00060	+	++	?	..	B
Apples	1 large	0.64	3	92	5	0.012	0.020	0.00048	+	+	++	..	B
Apricots, dried	9 halves	1.69	7	90	3	0.024	0.042	0.00050	?	?	?	..	B
Apricots, fresh	5	1.89	8	92	...	0.023	0.044	0.00052	.....	.....	.....	..	B
Asparagus	20 large stalks 8″ long	8.10	32	60	8	0.122	0.177	0.00451	+	+++	?	..	B
Avocado	½ medium	1.13	5	21	76	0.076	0.050	0.00647					
Bacon	4–5 small slices	1.68	13	...	87	0.001	0.018	0.00021	−	−	−	A	
Bananas	1 medium	1.32	5	89	6	0.009	0.031	0.00061	+	+	++	..	B
Beans, kidney, dried	½ cup	5.83	26	56	18	0.040	0.143	0.00216	+	+++	−	..	B
Beans, lima, dried	⅙ cup	5.17	21	75	4	0.022	0.097	0.00200	+	+++	−	..	B
Beans, lima, fresh	½ cup	5.79	23	72	5	0.023	0.108	0.00200	−	−	−	..	B
Beans, navy dried	⅛ cup	6.53	26	69	5	0.047	0.137	0.00203	+	+++	−	..	B
Beans, string, fresh	2⅓ cups 1″ pieces	5.54	22	71	7	0.110	0.126	0.00265	++	++	++	..	B
Beef, lean, round	slice 2¾″ × 1½″ × ¾″	13.63	55	...	45	0.008	0.147	0.00154	−	+	−	A	
Beets, fresh	4 beets 2″ diameter (1⅓ cup sliced)	3.47	14	84	2	0.064	0.084	0.00130	+	+	+	..	B

TABLE OF COMMON FOODS.[1]—(*Continued*)

Food material	100-calorie portions in common measure	Protein weight, grams	Protein calories per 100-calorie portion	Carbohydrate calories per 100-calorie portion	Fat calories per 100-calorie portion	Grams per 100 calories			Vitamins			Excess of	
						Calcium	Phosphorus	Iron	A	B and G	C	Acid	Base
Blackberries	½ cup (50 berries)	2.25	9	75	16	0.029	0.058	0.00104	−	+	+	..	B
Bluefish, fresh	piece 3″ × 2½″ × 1″	21.95	72	...	28	0.024	0.052	0.00124	−	−	−	A	
Bread, Boston brown	slice 3″ diameter ¾″ thick	2.39	10	80	10	0.056	0.082	0.00130	+	++	−		
Bread, graham, 100 per cent	slice 3″ × 3¾″ × ½″	3.42	14	80	6	0.020	0.084	0.00096	+	++	−	A	
Bread, graham, 50 per cent	1¼ slice 3¾″ × 3¼″ × ½″	3.51	14	80	6	0.015	0.060	0.000666	+	++	−	A	
Bread, rye	1⅓ slice 3½″ × 4″ × ½″	3.54	13	85	2	0.009	0.058	0.00063	+	++	−	A	
Bread, white	2 slices 3″ × 3½″ × ½″	3.60	14	80	6	0.011	0.036	0.00035	−	+	−	A	
Brussels sprouts	1 qt. box	7.32	29	65	6	0.132	0.585	0.00537	++	+++	+	..	B
Butter	1 tbsp.	0.13	..	...	100	0.002	0.002	0.00003	+++	−	−	neutral	
Buttermilk	1⅛ cups	8.39	33	54	13	0.294	0.271	0.00070	+	++	?	..	B
Cabbage	3½ cups chopped	5.08	20	71	9	0.143	0.092	0.00349	+	+++	+++	..	B
Cantaloupe	1 melon 4½″ diameter	1.52	6	94	...	0.043	0.038	0.00076	++	++	?	..	B
Carrots, fresh	1⅔ cups of ½″ cubes (4–5 young or 3–4″ long)	2.43	10	82	8	0.124	0.101	0.00133	+++	++	++	..	B
Cauliflower	1 small head 4½″ diameter	5.91	23	62	15	0.403	0.200	0.00197	+	++	+	..	B
Celery	4 cups of ¼″ pieces	5.94	24	71	5	0.421	0.201	0.00270	−	++	?	..	B
Cheese, American	3 tbsp. grated	6.50	26	...	74	0.212	0.156	0.00030	+++	+	−	A	
Cherries, fresh	20 cherries ⅞″ diameter	1.28	5	86	9	0.025	0.039	0.00051	?	?	?	..	B
Chestnuts, fresh	7 nuts	2.56	10	70	20	0.014	0.038	0.00029	−	+	−	..	B
Chicken, broilers	3 slices 3½″ × 2½″ × ¼″	19.91	80	...	20	0.012	0.215	0.00296	−	−	−	A	

Chocolate	3½ tbsp. grated	2.11	7	23	70	0.015	0.075	0.00044	−	−	−	A	
Clams, long	12 clams, ⅔ cup	16.74	56	36	8	0.241	0.237	0.00798	++	−	?	A	
Clams, round	.....	14.01	56	36	8	0.229	0.100	0.00948	++	−	?	A	
Cocoa, powder	2½ tbsp.	4.34	18	30	52	0.023	0.143	0.00054	−	−	−	A	
Cod, steak	piece 3¾″ × 2½″ × 1″	23.67	94	...	6	0.026	0.272	0.00127	.....	.....	.....	A	
Coconuts, fresh	3 tbsp.	0.97	4	19	77	0.004	0.013	0.00030	+	++	?	..	B
Corn, green	½ cup	3.06	12	78	10	0.006	0.102	0.00079	.....	.....	.....	A*	
Cornmeal, granular	3 tbsp.	2.59	9	80	3	0.005	0.053	0.00025	−	−	−	A	
Crackers, soda	4 crackers 2½″ × 2¾″	2.37	10	70	20	0.0053	0.025	0.00036	−	−	−	A	
Cranberries, fresh	2 cups	0.86	3	85	12	0.039	0.027	0.00129	?	?	+	A	
Cream, 18.5 per cent fat	¼ cup (scant)	1.28	5	9	86	0.050	0.044	0.00010	+++	++	?	..	B
Cream, 40 per cent fat	1⅔ tbsp.	0.58	2	3	95	0.020	0.020	0.00005	+++	++	?	..	B
Cucumbers	2 cucumbers 9″ long	4.60	19	69	12	0.090	0.191	0.00115	−	+	+	..	B
Currants, dried (Zante)	⅕ cup	2.62	3	92	5	0.026	0.061	0.00078	?	?	?	..	B
Currants, fresh	1½ cups	2.62	11	98	...	0.045	0.066	0.00087	?	?	?	..	B
Dandelion greens	2⅓ cups cooked	3.93	15	70	15	0.107	0.092	0.00491	++	++	+	..	B
Dates, dried, unstoned	3–4 dates	0.61	2	91	7	0.019	0.016	0.00086	?	?	?	..	B
Eggplant	6 slices, 4″ diameter ½″ thick	4.30	17	73	10	0.040	0.122	0.00180	+	+	−	..	B
Eggs, whole	1⅓ eggs	9.05	36	...	64	0.045	0.122	0.00205	+++	+	−	A	
Egg, white	7 whites	24.12	97	...	3	0.027	0.029	0.00020	−	−	−	A	
Egg, yolk	2 yolks	4.33	20	...	80	0.036	0.145	0.00230	+++	++	−	A	
Endive	14 stalks 5¾″	7.14	28	72	...	0.743	0.893	0.00471	.....	.....	.....	..	B
Farina, dark	¾ cup	3.07	12	84	4	0.013	0.118	0.00140	−	+	−	..	B
Farina, light	¾ cup	3.04	12	84	4	0.006	0.035	0.000222	−	−	−	..	B
Figs, dried	1½ large	1.36	5	94	1	0.051	0.037	0.00095	?	?	?	..	B
Filberts	8–10 nuts	2.22	9	7	84	0.041	0.050	0.00057					
Flour, buckwheat	2½ tbsp.	1.84	7	90	3	0.011	0.065	0.00034	−	−?	−	A	
Flour, graham	3 tbsp.	3.71	14	81	5	0.011	0.101	0.00100	+	++	−	A	
Flour, rye	3 tbsp.	1.94	6	91	3	0.005	0.082	0.00037	−	+	−	A	
Flour, white	4 tbsp.	3.20	12	85	3	0.006	0.026	0.00028	−	−?	−	A	
Flour, whole wheat	4½ tbsp.	3.84	15	80	5	0.009	0.066	0.00070	+	++	−	A	
Grapefruit	½ large	1.72	7	89	4	0.044	0.043	0.00058	+	++	+++	..	B
Grapes, fresh	1 large bunch	1.36	5	80	15	0.019	0.032	0.00031	+	+	+	..	B

TABLE OF COMMON FOODS.[1]—(*Continued*)

Food material	100-calorie portions in common measure	Protein weight, grams	Protein calories per 100-calorie portion	Carbohydrate calories per 100-calorie portion	Fat calories per 100-calorie portion	Grams per 100 calories			Vitamins			Excess of	
						Calcium	Phosphorus	Iron	A	B and G	C	Acid	Base
Grape juice	½ cup	.....	..	100	...	0.011	0.011	0.00030	−	+	+	..	B
Haddock, fresh	.....	24.06	..	...	...	0.027	0.276	0.00126	.....	.....	.....	A	
Halibut, steak	piece 3″ × 1¼″ × 1″	15.34	61	...	39	0.017	0.177	0.00083	+	+	?	A	
Ham, lean, smoked	slice 4¾″ × 4″ × ⅛″	7.43	29	...	71	0.004	0.080	0.00248	−	−	−	A	
Hominy	⅘ cup	2.35	9	90	1	0.003	0.031	0.00025	−	−	−	A	
Honey	1 tbsp.	0.12	1	99	...	0.002	0.006	0.00021	−	−	−		
Huckleberries, fresh	1 cup	0.82	3	90	7	0.027	0.011	0.00120	?	?	?	..	B
Kale	2⅓ cups	6.67	27	63	10	0.416	0.118	0.00608					
Kidney, veal	.....	13.50	..	...	...	0.008	0.145	0.00328	.....	.....	.....	A	
Kohlrabi	.....	6.47	..	...	...	0.249	0.230	0.00194	−	−	+	..	B
Lamb chops, broiled	lean meat of one chop, 2″ × 1½″ × ¾″	6.10	40	...	60	0.004	0.066	0.00093	−	−	−	A	
Lamb, leg, medium fat	slice 3½″ × 4½″ × ⅛″	8.52	41	...	59	0.005	0.092	0.00067	−	−	−	A	
Leeks	9 leeks 5″ long	3.69	15	72	13	0.178	0.018	?					
Lemons	3 large	2.26	9	76	15	0.081	0.049	0.00135	+	++	+++	..	B
Lemon juice	1⅛ cups	.....	..	100	...	0.060	0.026	?	+	++	+++	..	B
Lentils, dried	2½ tbsps.	7.37	29	68	3	0.031	0.126	0.00247	+	++	−	A	
Lettuce	2 large heads	6.28	25	61	14	0.224	0.220	0.00367	+	++	+++	..	B
Liver, beef	½ cup	15.83	63	5	32	0.014	0.171	0.00629	+++	++	+	A	
Macaroni, cooked	¾ cup	3.70	15	83	2	0.006	0.040	0.00033	−	−?	−	A	
Mackerel, fresh	¼ fish 11″ long without head or tail	13.48	61	...	39	0.014	0.155	0.00072	+	+	−	A	
Maple syrup	1½ tbsps.	.....	..	100	...	0.037	0.003	0.00105	−	−	−	neutral	

Milk, condensed (unsweetened)	3¾ tbsps.	2.70	23	26	51	0.092	0.072	0.00018	+++	++	?	..	B
Milk, evaporated (unsweetened)	3¾ tbsps.	5.75	23	26	51	0.189	0.146	0.00042	+++	++	−	..	B
Milk, whole	⅝ cup	4.76	19	29	52	0.174	0.134	0.00029	+++	++	+?	..	B
Milk, skimmed	1⅛ cup	9.26	37	56	7	0.331	0.262	0.00082	+	++	+?	..	B
Molasses, cane	1½ tbsp.	0.84	3	97	...	0.074	0.015	0.00255	−	+	−?	..	B
Mushrooms	20–2–, 1″ diameter	7.81	31	61	8	0.038	0.241	?	.....	.....	.....	..	B
Muskmelons	.....	1.52	..	...	...	0.043	0.038	0.00076	++	++	?	..	B
Mustard greens	.....	8.14	..	...	...	0.717	0.215	0.01824					
Mutton, leg, lean	slice 3″ × 3¾″ × ⅛″	10.38	33	...	67	0.006	0.112	0.00346	.....	.....	.....	A	
Oats, rolled	¼ cup	4.20	17	67	17	0.017	0.099	0.00096	−?	.....	−	A	
Olives, green	6–8 olives	0.37	1	16	83	0.041	0.004	0.00097	?	?	?	..	B
Onions, fresh	3–4 medium	3.30	13	81	6	0.069	0.093	0.00123	−?	+	++	..	B
Oranges, fresh	1 large	1.56	7	91	2	0.088	0.040	0.00039	+	++	++	..	B
Orange juice	1 cup	.....	..	100	...	0.067	0.027	0.00046	+	++	+++	..	B
Oysters	⅔ cup solids or 6–15 oysters	12.30	49	27	24	0.103	0.306	0.00893	+	?	+	A	
Parsnips	1 parsnip 7″ long 2″ diameter at top	2.47	10	83	7	0.091	0.117	0.00092	−?	++	?	..	B
Peaches, fresh	3 medium	1.70	6	91	3	0.038	0.057	0.00073	+	+	++	..	B
Peanuts	20–24 single nuts	4.69	19	18	63	0.013	0.073	0.00036	+	++	−	A	
Pears, fresh	2 medium	0.95	4	90	6	0.024	0.041	0.00047	?	+	?	..	B
Peas, dried	2 tbsp.	6.92	28	70	2	0.024	0.112	0.00160	.....	++	−	..	B
Peas, green	¾ cup	6.99	26	68	4	0.028	0.127	0.00165	++	++	++	..	B
Pecans	12 meats	1.31	5	8	87	0.012	0.045	0.00035	+	+	−?		
Peppers, green	5 peppers 3½″ long	6.18	25	70	5	0.023	0.100	0.00154	++	++	++	..	B
Pineapple, fresh	2 slices 1″ thick	.903	4	90	6	0.041	0.064	0.00116	++	++	++	..	B
Plums, fresh	3–4 large	1.19	5	95	...	0.024	0.038	0.00059	?	?	?	A?	
Pork, loin, chops, lean	½ chop (lean meat only)	8.05	32	...	68	0.005	0.087	0.00119	−	−	−	A	
Potatoes, sweet	½ medium	1.46	6	89	5	0.016	0.037	0.00041	++	++	++	..	B
Potatoes, white	1 medium	2.64	11	88	1	0.016	0.069	0.00156	+	++	++	..	B
Prunes, dried	4 medium	0.70	3	97	...	0.018	0.035	0.00100	++	++	−	A?	
Radishes	3 doz. red button	4.43	18	79	3	0.073	0.098	0.00205	−	+	+	..	B

TABLE OF COMMON FOODS.[1]—(*Continued*)

Food material	100-calorie portions in common measure	Protein weight, grams	Protein calories per 100-calorie portion	Carbohydrate calories per 100-calorie portion	Fat calories per 100-calorie portion	Grams per 100 calories			Vitamins			Excess of	
						Calcium	Phosphorus	Iron	A	B and G	C	Acid	Base
Raisins	½ cup seeded or 2 tbsp. seedless	0.76	3	88	9	0.019	0.038	0.00061	−	+	−	..	B
Raspberries, black fresh	1⅛ cups	2.57	10	76	14	0.074	0.078	0.00090	?	?	++	..	B
Rhubarb, fresh	4 cups of 1″ pieces	2.60	10	63	27	0.189	0.134	0.00433	?	?	+	..	B
Rice, brown	.....	2.52	..	...	...	0.003	0.060	0.00058	+	++	−	A	
Rice, polished	2 tbsp.	2.28	9	90	1	0.003	0.027	0.00026	−	−	−	A	
Rutabagas	⅓ large, 7½″ long 4½″ diameter	3.15	12	85	3	0.180	0.140	0.00128	−	++	+++	..	B
Salmon, fresh	.....	10.83	..	...	...	0.012	0.124	0.00059	+	?	?	A	
Sardines, canned	4 sardines, 3″ long	8.54	34	...	66	0.013	0.136	0.00067	.....	.....	.....	A	
Shad	.....	11.70	..	...	...	0.012	0.134	0.00062	.....	.....	.....	A	
Smelts	2 fish 6″ long	20.33	82	...	18	0.022	0.233	0.00116	.....	.....	.....	A	
Spinach, fresh cooked	2½ cups	8.79	12	80	8	0.281	0.276	0.01506	+	++	−	..	B
Squab	.....	6.81	..	...	...	0.004	0.074	0.00103	.....	.....	.....	A	
Squash, summer	½, 5″ in diameter	3.89	12	80	8	0.070	0.062	0.00233	++	?	?	..	B
Strawberries	1⅓ cups	2.56	10	76	14	0.104	0.072	0.00205	?	+	++	..	B
Tapioca	2 tbsp.	0.11	...	100	...	0.006	0.025	0.00045	−	−	−		
Tomatoes	2 cups (scant)	3.95	21	71	8	0.048	0.113	0.00175	+	++	+++	..	B
Tuna fish, canned in oil	.....	9.12	..	...	...	0.010	0.105	0.00050	.....	.....	.....	A	
Turkey meat, light, cooked	slice 4″ × 2¼″ × ¼″	18.95	75	...	25	0.011	0.204	0.00285	.....	.....	.....	A	
Turkey meat, dark, cooked	1 slice 4″ × 2½ × ¼″	20.05	80	...	20	0.012	0.216	0.00302	.....	.....	.....	A	
Turnip greens	2½ cups, cooked	9.18	36	57	7	1.048	0.187	0.02245	++	++	+		
Turnips, fresh	2 cups	3.30	13	82	5	0.161	0.117	0.00127	−	++	++	..	B

Veal, leg, lean	slice 2″ × 2¾″ × ⅛″	**17.45**	**71**	...	29	0.010	0.188	0.00213	−	−	−	A	
Walnuts, California	8–16 meats	2.61	11	7	82	0.013	0.051	0.00030	−	++	?	A	
Watercress	5 bunches 3″ long 3″ diameter	3.18	13	67	20	0.850	0.023	0.00864	+	+	++	..	B
Watermelon	¾″ slice, 6″ diameter	1.32	5	89	6	0.038	0.010	0.00099	?	?	?	..	B
Wheat, shredded	1 biscuit	3.51	13	82	5	0.011	0.089	0.00123	+	++	−	A	
Whey	1⅔ cups	3.74	9	45	6	0.165	0.131	?					

[1] Sources: Rose, Mary Swartz, *Laboratory Handbook for Dietetics*, The Macmillan Company, 1930. The acid-base excess is adapted chiefly from Dorothy S. Waller, *Nutritive Value of Foods*, George Wahr, Ann Arbor, Michigan, 1932.

In McLester, *Nutrition and Diet in Health and Disease* (1931), Part III; and in Sherman, *Food Products*, will be found more detailed lists of foods as variously prepared, different cuts of meats, etc. Rose, in *Feeding the Family* (1931), Appendix, gives many recipes, carefully analyzed and distributed by food values and composition; her book is valuable as a guide in food preparation as well as analysis.

APPENDIX B

ANESTHETICS USED IN CHILD BIRTH

Three forms of relief from pain are used in childbirth: (1) *Anaesthesia*, which produces relief through rendering the patient unconscious. Ether, chloroform, and ethylene-oxygen gas are the agents commonly used for this purpose. (2) *Amnesia*, or forgetfulness of pain, is produced by the so-called "Twilight Sleep," which uses morphine with scopolamine or hyocine. (3) *Analgesia*, or loss of sensation without entire loss of consciousness, may be secured by the use of nitrous oxide (laughing gas). Analgesia is said to be obtained by the use of a relatively new method developed in New York City by Doctors Davis and Gwathemy, which involves the use of morphine, magnesium sulphate, and ether.

Of these various methods and agents, ether was the first to be discovered in Scotland in 1847. The discovery of chloroform soon followed. The use of these anaesthetics in childbirth was introduced in Boston about the middle of the century by Dr. Channing.

We do not like to think of the suffering of the women of the world before the introduction of anaesthesia. It was no wonder travail was considered to be a divine curse for some ancient misdemeanor. Indeed, the use of anaesthetics in labor was combatted for a long time by clergy and some laity because this seemed to them to be circumventing the divine will as expressed in the Biblical edict: "In sorrow shalt thou bring forth thy children."

Chloroform is the agent most commonly used by the general practitioner in confinements in the home. It is not desirable to put the subject soundly enough to sleep to retard the uterine contractions. Chloroform takes effect quickly and passes off quickly. It is, therefore, possible to take the edge off the severest pains without interfering with the progress of labor. Moreover, for some reason, women in labor bear chloroform better than they do under other circumstances.

Ether.—Some physicians prefer ether at all times—especially if deep anaesthesia is necessary for forceps delivery or perineal repair. Ether must be administered by a well-trained person.

Nitrous oxide or "laughing gas" produces quick loss of sensation without entire loss of consciousness. It is an ideal anaesthetic for childbirth, but unfortunately it requires a complicated apparatus which cannot be easily transported and it must be administered by a skillfully trained operator. It is therefore possible to use this only in specially equipped hospitals, and a larger anaesthetic fee is usual than where ether or chloroform is used.

Ethylene-oxygen Anaesthesia.—Another method of surgical and obstetrical anaesthesia has come into extensive use since 1924, when it was developed simultaneously by Dr. Carter of Chicago and Dr. Brown of Toronto. Ethylene gas must be mixed with oxygen under pressure, a procedure which requires special apparatus and a trained operator. It is said to a safe, quick anaesthetic and admirably suited to obstetrical purposes.

Twilight sleep or scopolamine-morphine analgesia was first extensively used in Germany, notably at Freiburg. The extravagant reports which found their way into the press led wealthy women to make the trip to Freiburg to be confined where they believed they would be relieved of all pain and danger. Likewise, the medical profession of the United States tried it extensively, but promptly found it unsuited to general practice, and dangerous to both mother and child, especially to the child, unless administered under favorable conditions and by highly skilled operators.

In this method the two drugs reinforce each other—the morphine deadening the pains to some extent, while the scopolamine has the curious effect of "uncoupling" the memory. When the effect of the drug wears off the subject has no remembrance whatever of anything occurring while under its influence. There is very little shock or after-effect when successfully administered, but the baby is apt to be narcotized and is made to breathe with difficulty if too much drug has been used.

In normal cases, in hospitals or homes, when conditions can be controlled and a skilled administrator is available, there is no reason why it may not be used. Certain of the prominent obstetricians of the country use twilight sleep with great success.

Morphine–magnesiumsulphate–ether.—This method of analgesia is said to allay pain with no injury to mother or child or unpleasant after-effects. Morphine is used hypodermically, also magnesium sulphate. At a certain stage of labor ether-in-oil is injected in the rectum.

It is still somewhat in the experimental stage on account of the complicated and exact technique of administration, and is rather strictly a hospital procedure.

Every obstetrician has acquired a favorite technique and method. If he is intelligent and skillful a woman may safely submit to his judgment both as to amount and kind of relief used. While it is desirable that as little anaesthetic as possible be used, and much depends on the courage and cooperation of the woman herself, yet it is inadvisable and unnecessary to deplete her strength and subject her to prolonged suffering.

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Van Blarcom, Carolyn: *Obstetrics for Nurses*, pp. 286–294, The Macmillan Company.

APPENDIX C

IMMUNIZATION

The normal infant is born with considerable immunity to many diseases to which he later becomes susceptible. This birth immunity begins to fade rapidly at about six months. It has been proved that artificial immunity may safely and successfully be established to smallpox and diphtheria between six and twelve months of age by inoculation with smallpox vaccine and with toxin-antitoxin or with toxoid. Both these diseases are highly fatal to young children. It is now strongly advocated by all pediatricians and public health authorities that all infants be so protected before they are one year old. This immunity is relatively lasting, often life-long.

Inoculation with scarlet-fever serum confers immunity for a less certain period of time. It is commonly advised that young children receive scarlet fever serum only if they have been exposed to the disease or if it occurs in the family.

Whooping cough serum (pertussin) seems to make the attack of the disease shorter and milder, but apparently confers little immunity. It is therefore commonly used only as treatment.

Convalescent serum secured from persons who have had the disease is being successfully used in the prevention and treatment of measles. The immunity is brief but valuable for the protection of younger children when an older child in the family has the disease.

Convalescent serum is also being used in infantile paralysis but the protective value is not yet well established.

GLOSSARY

Afferent—Conducting inward to a central part or organ. Afferent nerves—conveying sensations from organs to brain as opposed to efferent, conveying outward toward a part or organ.

Align—To adjust, "form to a line."

Amine—Any member of a group of chemical compounds formed from ammonia (a nitrogen compound, NH_3) by replacing hydrogen with an alcohol radical.

Amorphous—Having no definite form; shapeless.

Amphibian—An animal or plant accustomed to live both on land and in water.

Ampulla—A flasklike dilation; especially the dilated end of semicircular canal of the ear, or that of a mammary gland.

Anorexia—Lack or loss of the appetite for food.

Ash—The incombustible residue remaining after any process of incineration (burning).

Atony—Lack of normal tone or strength.

Attenuation—Act or process of thinning or weakening, especially the weakening of the toxicity of a virus or of a microorganism by repeated inoculation, successive culture, etc.

Autonomic—Self-controlling; having independent functions (automatic).

Bland—Mild or soothing.

Buffer—Any substance in a fluid (as the gastric juice or blood) which tends to lessen the change in hydrogen-ion concentration (reaction) which otherwise would be produced by adding acids or alkalies.

Centimeter—One-hundredth part of a meter, or 0.3937 lineal inch.

Coitus—Sexual intercourse; copulation.

Commissural—Pertaining to or acting as a commissure or junction, means of joining, *e.g.*, the tissue which joins corresponding right and left parts of the brain and spinal cord.

Congenital—A condition present at birth. Often used in the sense of acquired during prenatal life as distinguished from hereditary conditions.

Conjugation—The union of one organism with another for the exchange of nuclear material.

Consensus—Agreement in opinion, custom, or function.

Contraception—The prevention of conception or impregnation of the ovum by the sperm.

Contraceptive—Anything used to prevent conception.

Copulation—Sexual intercourse; coitus.

Defecation—The discharge of fecal matter from the bowel.

Dextrose—Grape sugar; same as glucose.

Differentiate—To make different in the process of development. To acquire a distinct and separate character.

Dominant—If two well-defined varieties of the same species be cross-fertilized, the resulting hybrid offspring will show the distinguishing characteristics of one of the parents only, this inherited characteristic being termed *dominant.* The characteristic of the other parent, however, known as *recessive,* is latent and may appear in the next generation bred from the hybrid.

Dorsal—Pertaining to the back.

Dysgenic—Detrimental to the race or tending to counteract movements for race improvement; opposed to eugenic.

Efferent—Conveying away from a part, as impulses from a nerve center; opposed to afferent.

Epiphysis (plural epiphyses)—A part or process of a bone which ossifies separately and subsequently becomes integrated with the main part of the bone. In higher vertebrates the ends of the long bones of the limbs are formed in this way, and in man in some cases do not unite with the shaft of the bone until about the twentieth year. In rickets the epiphyses of the long bones are enlarged.

Erectile—Capable of erection; the state of a part which has become hard and swollen by the accumulation of blood, as the penis.

Estrum, oestrum—The period of "heat, "rut," estrus, or sexual excitement in the female of animals; pertaining to the rutting of animals.

Extensor—Any muscle which performs extension, as opposed to flexion.

Fatigability—Easily susceptible to fatigue.

Fat-soluble—A substance which will not dissolve in water but which will dissolve in fat solvents such as ether and alcohol.

Fertility—State or quality of being fertile; fruitful, not sterile.

Fission (division)—A form of asexual reproduction in which the cell simply divides into two approximately equal parts.

Flexor—Any muscle that flexes or bends a joint, as opposed to extension.

Gamete—A sexual cell; a conjugative cell-element which unites with another element to form a zygote.

Gel—A colloid which is firm in consistency, though containing much liquid; a colloid in gelatinous form.

Gestation—Pregnancy.

Glucose—Grape sugar or dextrose.

Glycosuria—The presence of an abnormally high percentage of glucose (sugar) in the urine.

Gradients—Rising or descending by regular degrees of inclination. The rate of increase or decrease of a variable magnitude. Here applied to areas of graded activity in living tissues.

Grape sugar—See glucose.

Hemorrhoid—A "pile" or vascular tumor of the rectal mucous membrane.

Hybrid—A cross-bred animal or plant (the male and the female having differing traits or characters).

Hypersecretion—Excessive or too copious secretion.

Hyposecretion—Diminished or too little secretion.
Hypotension—Diminished tension; *e.g.*, lowered blood pressure.
Immunological—Pertaining to immunity.
Indubitable—Too evident for doubt; unquestionable.
Irradiation—Treatment by *x*-rays, ultra-violet light, or other form of radio-activity.
Kilometer—One thousand meters; 3,272.5 feet.
Labile—Readily undergoing change, as in cleavage or molecular arrangement; unstable.
Lethal—Deadly, fatal.
Masturbation—The habit of handling the genitals.
Maturation—The stage or process of becoming mature. Also, the final series of stages in the formation of the egg, by which its nucleus is prepared for union with the sperm nucleus.
Metal—Any element marked by luster, malleability, ductility, and conductivity of electricity and heat.
Millimeter—One-thousandth part of a meter, or 0.03937 inch.
Mineral—A nonorganic homogeneous substance.
Molecular weight—The weight of any molecule of gas or vapor as compared with some standard of atomic weight.
Mucosa—The mucous membrane.
Multipara—A woman who has borne more than one child.
Myxedema—A disease, probably due to hypofunction of the thyroid gland, marked by dropsy-like swelling, especially of face and hands, smallness of thyroid gland, slowing of pulse-rate, dryness and wrinkling of skin, falling of hair, dulling of mental activity, sluggishness of movement, and retardation of the rate of basal metabolism.
Neonatal—Pertaining to the new-born; technically in vital statistics, the first month of life.
Night blindness (nyctalopia)—Failure or imperfection of vision at night or in a dim light.
Nucleolus ("little nucleus") (plural nucleoli)—A round achromatic body within the nucleus of a cell.
Pangen—A hypothetical supramolecular protoplasmic unit once supposed to convey the traits of inheritance.
Parturition—The act or process of giving birth to a child.
Perineum—The space, or area, between the anus and the genital organs.
Peristalsis—Worm-like movement such as that by which the alimentary canal propels its contents.
Peritoneum—The serous membrane which lines the abdominal walls and covers the intestines and other abdominal organs.
Pigment—Any normal or abnormal coloring matter of the body.
Polypoid (polyploidia)—A sport or mutation in which the sets of chromosomes are doubled or trebled, as if fertilized without undergoing maturation division.
Polyuria—Excessive secretion and discharge of urine.
Postnatal—Occurring in the child after birth.

Postpartum—Any condition occurring in the mother after delivery or childbirth.

Prenatal—Existing or occurring before birth.

Primipara—A woman who has given or is giving birth to her first child.

Primordial—Of the simplest and most undeveloped character; primitive.

Progeny—Children; offspring.

Provitamin—A substance the presence of which is necessary to the formation of a particular vitamin.

Psychasthenia—A functional neurosis marked by states of pathologic fear or anxiety, obsessions, and peculiar feelings of unreality.

Puerperium—The period or state of confinement; the period required for the mother's full recovery after giving birth to a child.

Recessive—See dominant.

Salts—Any compound of base or radical and an acid.

Satiety—Fullness of gratification, complete satisfaction, of the appetite or of any other sensuous desire.

Scorbutus—Latin for scurvy, a nutritional disease due to deficiency of vitamin C.

Sebaceous—Pertaining to, secreting, or composed of, fat.

Sedentary—Characterized by, or requiring, much sitting.

Seminal emission—Involuntary discharge of semen.

Semipermeable membrane—One which permits the passage of a solvent, such as water, but prevents the diffusion of molecules of the dissolved substance.

Sensitization (protein)—That bodily state in which the individual is hypersusceptible to some foreign (not existing in the body) protein. When introduced, the foreign protein sets up a specific reaction.

Sequence—Simple succession.

Spastic—Of the nature of or characterized by spasms.

Specificity—The quality or fact of being specific.

Stable—Firmly established, not easily moved; fixed.

Sterol—One of the fat or fat-like substances known as *lipins* or *lipoids*. Soluble at ordinary air temperature in alcohol, ether, or other fat-solvent. Cholesterol and ergosterol are well-known examples.

Subsidize—To set apart a sum of public or private money for a specific project or purpose, such as building roads or the hygiene of maternity and infancy.

Synapse—The contact or point of contact between dendrites, forming the place where a nervous impulse is transmitted from one neuron to another.

Synergia—Correlated, grouped, or "timed" movements resulting in the performance of a unified, complex act.

Synthetic—Produced by synthesis; artificial.

Synthesize—To combine by synthesis; to unite. To unite by the process of "building up" a compound by the union of simpler compounds or of its elements.

System—A set or series of parts or organs which unite in a common function.

Tetany—A disease characterized by painful, tonic, spasm of the muscles of the extremities; supposed to be due to a toxic agent.

Threshold of learning—The point at which insight or habit is established.

Transformer—An apparatus for transforming an electric current from a high to a low potential or *vice versa*.

Trophic—Of or pertaining to nutrition.

Vegetative—Concerned with growth and with nutrition; also, functioning involuntarily or unconsciously.

Venereal—Due to or propagated by sexual intercourse.

Ventral—Of or pertaining to the front of the body as opposed to the dorsal.

Vicarious—Acting as or being a substitute; putting one's self in another person's place.

Wassermann test—A test for syphilis in which the blood of the suspected individual is combined with an antigen for syphilis. A "positive" reaction is strongly indicative of syphilis, but should be supported by other evidence to be conclusive.

Water-soluble—Any substance which dissolves in water. Several of the vitamins are termed water-soluble to distinguish them from the fat-soluble vitamins.

Zygote—The individual resulting from the fusion of two gametes (germ cells).



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